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UPPER CAMBRIAN AND LOWER ORDOVICIAN TRILOBITA AND OSTRACODA FROM VERMONT

BY PERCY E. RAYMOND

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INTRODUCTION AND ACKNOWLEDGMENTS

During the last fifteen years, a renewed attack has been made upon the difficult problems presented by the complicated fold and thrust structures in the older Paleozoic strata of northwestern Vermont. The campaign led by Arthur Keith bids fair to resolve the difficulties which baffled such eminent and acute geologists as Sir William Logan, Elkanah Billings, James Hall, Jules Marcou, and Charles D. Walcott. Like Sir William, Keith realized that fossils might be the master key for opening the secrets of this chamber of mysteries, and at an early date induced Charles Schuchert to collaborate in the work. Schuchert has been kind enough

to turn over for study such Upper Cambrian and Lower Ordovician trilobites as he and his associates have collected during visits to the area over a long period, and several years ago the writer described such fossils as had then been collected from what are now known as the Gorge (formerly Milton or Missisquoi), Highgate, and Grandge (formerly Georgia) formations. At that time, rather large collections had been made from what has been called the main zone, or zones 2 and 3, of the Gorge; but little was known of zone 1—80 feet below zone 2—and almost nothing of the fossils in the boulders in the Corliss conglomerate, of those in the Rockledge conglomerate or its sandy calcareous matrix, or of those in the calcareous lentils in the Hungerford shale, which underlies it. Persistent collecting by Schuchert in zone 1, and by Schuchert, Keith, Prindle, Clark, and McGerrigle in the Rockledge conglomerate and the strata beneath it, has brought to light a fauna, or, rather, two faunules, whose trilobites are described in the present paper. The writer has also included certain species collected by Schuchert, Clark, F. B Phleger, McGerrigle, and Raymond from an exposure of the Highgate at a locality about which there is considerable difference of opinion. This is on the Grandge farm, half a mile south of the International Boundary, and about 4.5 miles north of Highgate Center, Vermont.

The writer is indebted to Professor Schuchert for his kindness in loaning the fossils for description, and for aid in paying for the drawings illustrating the Upper Cambrian species.

The fauna of the Gorge formation is of unusual interest to the paleontologist for several reasons. In the first place, it shows a remarkable variety of species; hardly any other Upper Cambrian fauna has so many trilobites. There is also a curious intermingling of types not usually found together. Some species have their nearest relatives in China, others in northern Europe. Most remarkable is the presence of a near ally of *Apatokephalus,* a genus characteristic of the lowest Ordovician strata in Norway, Sweden, and England, here associated with genera represented in the Upper Cambrian formations in the Minnesota-Wisconsin region. Another peculiar feature is that almost all the trilobites are small. They may, in fact, be described as dwarf faunas, although the interpretation that they are all young individuals is not impossible. All are moulted tests, whole trilobites, or even whole cephala, being extraordinarily rare. In fact, there is no entire specimen from the Gorge, and very few from the Hungerford shale. Another peculiar feature of the fauna is the large number of species in which the cranidium either has no brim, or has a convex one with no rim. The significance of this, if there is any, is not apparent.

In the description of the species, the writer has been forced to erect a large number of new genera, most of which are, perforce, very incom-

pletely known. A very conservative attitude was adopted in the previous paper, few new generic names having been proposed. It may be that at this time too many have been made. The finding of more complete specimens will afford the only possible solution of many taxonomic problems.

The writer is indebted to Miss Clara M. LeVene for her revision of the manuscript, and to Mrs. Cecil Lalicker and Mrs. Vladimir Okulitch for labors upon the illustrations, and for their care in making measurements of typical specimens.

SYSTEMATIC DESCRIPTIONS

Class CRUSTACEA Leach

Subclass TRILOBITA Walch

Order HYPOPARIA Beecher

Family ENTOMASPIDAE Ulrich

Genus *Entomaspis* Ulrich

Entomaspis clarki sp. nov.

(Plate 1, figure 1; Plate 4, figure 1)

Cephalon nearly semicircular, with a wide, slightly concave brim. The glabella is short, narrow, and has one pair of obliquely directed furrows. It is set in so deep a depression, surrounded by the wide cheek-roll, that the top rises but little above the general surface. Both eyes are imperfect, but from the scars, it appears that they were large. The eye-lines are prominent. The cheek-roll is lower in front of the glabella than at the sides, and has a small median boss. The brim is radially grooved by furrows, which begin as faint depressions on the cheek-roll and become deeper and broader on the concave brim. There is a narrow, somewhat irregular rim.

MEASUREMENTS: Length of cephalon (holotype), about 12 mm.; length of glabella, about 2.5 mm.; width of brim, about 2 mm. Length of cephalon (paratype), 9 mm.; width, 15 mm.; length of glabella, 4 mm.; width of brim, 2.5 mm.

This species seems to be closely allied to *Entomaspis radiata* Ulrich,[1] but differs from it in having a shorter and more pointed glabella, one instead of two pairs of glabellar furrows, a narrower cheek-roll, a less well developed rim, and in having the eyes farther forward.

It is possible that this is the species which Billings[2] described as *Harpides ? desertus*. That species was based on a glabella found in the bed of the Pike River at Bedford, Quebec. Its shape agrees with that of the glabella of the present specimen, but the glabellar furrows appear to be longer.

Ulrich, in his generic description, compares *Entomaspis* with *Harpes*, but not with *Harpides*, which it more closely resembles. Unfortunately, representatives of the latter genus are extremely rare and also badly preserved. The present species is referred to *Entomaspis* rather than to *Harpides*, chiefly because the genotype of

[1] E. O. Ulrich, A. F. Foerste, and Josiah Bridge: *Systematic paleontology [of Cambrian and Ordovician formations of Ozark region, Missouri]*, Mo. Bur. Geol. Mines, 2d ser., vol. 24 (1930) p. 212, pl. 19, figs. 14-16.

[2] Elkanah Billings: *Paleozoic fossils, vol. 1*, Geol. Surv. Canada (1865) p. 333, fig. 321.

the latter is a trilobite with an extremely wide cephalon, and a relatively much smaller glabella. The radial furrows are much more regular in *Entomaspis* than in either of the Bohemian species of *Harpides*. If *Harpides rugosus* (Sars and Boeck) is a true *Harpides*, there are no smooth depressed areas beside the glabella, such as are present in *Entomaspis*.[3]

Ulrich, in his restoration of *Entomaspis radiata*, has shown large eyes and the posterior branch of a facial suture. The eyes are poorly preserved on the writer's specimens. They appear to have been rather large, but it cannot be determined whether they are compound, or are small groups of ocelli, such as occur in *Harpes*. They are not larger than those of *Harpes*. Specimens examined by the writer show no trace of a facial suture, and it would seem improbable that the line drawn by Ulrich could show its real course, for it does not connect with the effective suture, which crosses the dorsal surface of the genal spine, as does that of the trinucleids. The effective suture may, of course, be wholly secondary, but, even so, one would expect it to be a continuation of the primitive suture.

FORMATION AND LOCALITY: Five imperfect cranidia were collected by Schuchert, McGerrigle, and the writer from a zone in the lower part of the Highgate formation, about 15 feet beneath the Grandge formation on the Grandge farm 4.5 miles north of Highgate Center, Vermont. The holotype is No. 3843 in the Museum of Comparative Zoölogy. The paratype is in the Yale University Museum.

Family SHUMARDIIDAE Lake

Genus *Shumardia* Billings

Shumardia granulosa Billings

1862. *Shumardia granulosa* BILLINGS, Pal. Foss., vol. 1, Geol. Surv. Canada, pt. 3, p. 92, fig. 83.
1924. *Shumardia granulosa* CLARK, Bull. Am. Paleont., vol. 10, no. 41, p. 88, pl. 9, figs. 1-6.

Two small pygidia were collected from the lower Highgate on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. One is about 1 mm. long and has five rings on the axial lobe and six pairs of pleural ribs. They are No. 3835 in the Museum of Comparative Zoölogy.

Family RAPHIOPHORIDAE ? Angelin

Genus *Diplozyga* nov.

Raphiophoridae ? with obtusely subtriangular pygidium, with few axial rings, and with steeply inclined flattened border. Genotype: *Diplozyga striata* sp.nov.

Diplozyga striata sp.nov.

(Plate 1, figure 2)

Pygidium obtusely triangular, with a wide border, which is bent downward at almost a right angle. As viewed from above, the high axial lobe appears to reach the posterior end. It has five rather obscurely defined rings. The surface of the pleural lobes is almost flat, and shows three pairs of rather poorly developed ribs.

[3] Joh. Chr. Moberg and Carl O. Segerberg: *Bidrag till kännedomen om Ceratopy-geregionen med särskild hänsyn till dess utveckling i Fogelsångstraken*—Kongl. Fysiografiska Sällskapets Handlingar, N. F. Bd. 17, no. 7 (1906) p. 85, pl. 5, fig. 1.

The most striking feature of the pygidium is the extraordinary striated border, which is almost vertical and gives the impression of lapping over the posterior end of the axial lobe. It appears like a doublure. The same sort of border is present on the pygidia of some species of *Raphiophorus* and *Lonchodomas*. Enrolled specimens of the latter show that it is an adaptation which permits the pygidium to fit into the cephalon just as a box fits into its lid.

Similar vertical borders are developed to some extent in other genera, even in some that are not members of the Hypoparia. The present reference of the genus is, therefore, subject to revision.

MEASUREMENTS: Length of pygidium, 2 mm., width, 3 mm.; length of axial lobe, 2 mm., width at front, 1 mm.

FORMATION AND LOCALITY: Two pygidia were collected at the Grandge farm, 4.5 miles north of Highgate Center, Vermont, in the lower part of the Highgate formation. The holotype is No. 3823 in the Museum of Comparative Zoölogy.

Order OPISTHOPARIA Beecher

Family TRIARTHRIDAE Ulrich

Genus *Triarthroides* nov.

Triarthridae with vaulted cranidium, deflected brim, and no rim. Genotype: *Triarthroides cyclas* sp.nov.

Triarthroides cyclas sp.nov.

(Plate 1, figure 3)

Cranidium highly convex, almost circular, with deflected brim and cheeks. Glabella long, raised somewhat above the general surface, outlined by narrow, shallow furrows. There are two pairs of glabellar furrows, the first pair turning diagonally backward, the second ones parallel to the nuchal furrow, almost meeting at the inner ends. The nuchal segment is narrow. The cheeks are steep, the palpebral lobes small, midway in the head, and far from the glabella. The brim is narrow and steep.

MEASUREMENTS: Length of cranidium, 1 mm., width, 1.25 mm.

No trilobite was found which seems closely allied to the present one unless it be *Desmetia annectans* (Walcott).[4] Both have small convex cranidia without a rim, but *Desmetia* has deep circumglabellar furrows and three pairs of glabellar furrows. The eyes are (presumably) farther forward and nearer the glabella than in the present species.

FORMATION AND LOCALITY: Three cranidia were collected from the lower part of the Highgate formation on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. The holotype is No. 3822 in the Museum of Comparative Zoölogy.

Family REMOPLEURIDAE Hawle and Corda

Genus *Apatokephalus* Broegger

The name *Apatokephalus* was applied by Broegger to a group of species, the first of which, *Trilobites serratus* Boeck, has been accepted as the genotype. This species was based upon a pygidium collected from the upper part of the *Ceratopyge* zone in the Oslo district of Norway.

[4] C. D. Walcott: *Cambrian geology and paleontology, V, no. 3, Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75, no. 3 (1925) p. 83, pl. 15, figs. 24 and 25.

It has been the general custom to identify all the European specimens as belonging to one species, although Moberg and Segerberg named a variety, and Broegger suggested a new name for the Swedish specimens.

There seems to be some variation among the pygidia assigned to *A. serratus*, which is interesting in view of the fact that, although the cranidia of the specimens which Schuchert has collected in Vermont are typical of *Apatokephalus*, the pygidia differ in several respects from those of northern Europe.

Apatokephalus serratus (Boeck)

1838. *Trilobites serratus* Boeck, Gaea Norvegica, vol. 1, p. 139.
1854. *Centropleura serrata* Angelin, Pal. Scandinavica, p. 88, pl. 41, fig. 10.
1884. *Dicelocephalus serratus* Broegger, Sil. Etagen 2 u. 3 im Kristianiagebiet u. auf Eker, p. 126, pl. 3, figs. 7 and 8.
1884. *Remopleurides dubius* Broegger, Sil. Etagen 2 u. 3 im Kristianiagebiet u. auf Eker, p. 127, pl. 3, fig. 14.
?1896. *Apatokephalus dubius* Broegger, Separate publication in advance of the article, which appeared in Nyt Mag. f. Naturvid., vol. 36, p. 13, fig. 5a, b.
1897. *Dicellocephalus serratus* Holm, Geol. Fören. Förhandl., vol. 19, p. 465, pl. 8, figs. 3-5.
1898. *Apatokephalus dubius* Broegger, Nyt Mag. f. Naturvid., vol. 36, fig. 5a, b.
1906. *Apatokephalus serratus* Moberg and Segerberg, Lunds Univ. Arssk., vol. 2, nr. 2, p. 88, pl. 5, figs. 9 and 11.
1920. *Apatocephalus serratus* Stoermer, Norsk Geol. Tidssk., vol. 6, p. 10, pl. 2, fig. 3.
1927. *Apatokephalus serratus* Stubblefield and Bulman, Geol. Soc. London, Quart. Jour., vol. 83, p. 136, pl. 4, fig. 7.
1930. *Apatokephalus serratus* Lake, Paleontogr. Soc., vol. 83, p. 122, pl. 14, fig. 14.
1932. *Apatokephalus serratus* Lake, Paleontogr. Soc., vol. 84, p. 149, pl. 19, figs. 1 and 2.

All pygidia which have been assigned to this species have a denticulate margin without a rim. The posterior end of the axial lobe is acutely pointed, appearing like a spine in bas-relief.

Angelin's figure, which is obviously conventionalized, shows five pairs of denticles. In 1884, Broegger figured one pygidium with six pairs of denticles and another with seven. Holm figured two with six pairs each. All these were from the vicinity of Oslo. Moberg and Segerberg figured a single pygidium from Ottenby, Sweden, with six pairs.

Angelin depicted the spines as if all were of equal size, but all other figures indicate that the inner pair are the smallest, and that the second pair from the median line are distinctly smaller than the third pair. The outer spines are long and strong. If the spaces between the denticles were filled up, the outline would be deeply concave in the middle.

Genus *Protapatokephalus* nov.

Remopleuridae with cranidium identical with that of *Apatokephalus* except for the absence of a row of pits in the intra-marginal furrow. Pygidium with a broader axial lobe, flatter spines, and more rounded outline than in *Apatokephalus*. Genotype: *Protapatokephalus arctostriatus* sp. nov.

This genus is proposed to include four species of trilobites which for several years the writer believed to be true *Apatokephalus*. Their presence in an Upper Cambrian fauna was inconsistent with this designation, but the cranidia were so similar to those of Scandinavian specimens of *Apatokephalus* that it was not felt that a separation was justified.

A recent visit to Oslo, however, made it possible to study Norwegian material, which has never been accurately illustrated. Through the kind offices of Dr. Leif

Stoermer and Dr. Anatol Heintz, this material was borrowed and direct comparison was made with American specimens. As a result, the latter are now placed in a separate genus, which is unquestionably ancestral to the North European lowest Ordovician forms. The chief differences lie in the pygidia. Whether this stock originated in North America or in Asia is not known, but it is interesting to note that it is an immigrant in Europe, where it was first described. This is one of the few cases in which the ancestor of an Ordovician animal has been found in the Upper Cambrian.

Protapatokephalus arctostriatus sp.nov.

(Plate 1, figures 4-7)

Cranidium of the same shape as that of *Apatokephalus serratus*. Glabella depressed-convex, almost flat, widest between the palpebral lobes. Brim tilted downward, bordered by a narrow elevated rim. There are three pairs of glabellar furrows, the anterior ones short and faint, the others narrow but distinct. The surface is covered with raised lines, which show a somewhat labyrinthine pattern. The associated free cheek is broad, has a small intergenal spine, and a long, flat, ribbon-like genal spine. Obscure nervures radiate from the eye.

The pygidium arbitrarily assigned to this species has a large, short, highly convex axial lobe and flat pleura. The axial lobe has two rings and a pair of large nodes near the posterior end. Behind the main body of the lobe is a low, narrow, pointed extension, which reaches nearly to the end of the pygidium.

On the pleural lobes are five pairs of low ribs, at the end of each of which is a flat spine. In the middle are two more spines, making six pairs in all. The outer three pairs are considerably longer than the inner ones.

MEASUREMENTS: Length of cranidium, 7 mm.; length of glabella, 5.1 mm.: width between palpebral lobes, 4 mm. Length of pygidium, 4.5 mm., width, 8 mm.; length of axial lobe (without terminal prolongation), 3 mm., width, 2.25 mm.

FORMATION AND LOCALITY: Several cranidia and a few free cheeks and pygidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype (cranidium) is No. 14701 in the Yale University Museum, the paratypes bearing the catalogue numbers 14702 (cranidium) and 14701 (pygidium and free cheek).

Protapatokephalus granulatus sp.nov.

(Plate 1, figure 9)

This species differs from *P. arctostriatus* in ornamentation, the glabella being faintly granulose instead of striated, and the short brim smooth. The facial sutures turn outward in front of the eyes, so that the anterior part of the cephalon is proportionately wider than is that of the previous species.

MEASUREMENTS: Length of cranidium, 2.5 mm., width at eyes, 3 mm.; width of brim, 2.5 mm.; length of glabella, 2 mm., length of brim, 0.5 mm.

FORMATION AND LOCALITY: A single cranidium was collected by Schuchert from the lowest zone in the Gorge formation at Highgate Falls, Vermont. It is No. 14703, Yale University Museum.

Protapatokephalus spiculatus sp. nov.

(Plate 1, figure 8)

This species is known only from the pygidium, which has four rings on the axial lobe and six pairs of marginal spines. The axial lobe is convex, rising high above the rather flat pleural lobes. It terminates in a narrow median rib. Each marginal

spine is an extension of a single pleural rib, the outer spines being longer and more acutely pointed than the inner ones.

This type of pygidium is more like that of *Apatokephalus serratus* than is that of any of the American species of *Protapatokephalus,* but differs from it in having shorter outer spines, fewer rings on the axial lobe, and in lacking the pustulose ornamentation of the surface.

MEASUREMENTS: Length of pygidium, 3 mm., width, 5 mm.; length of axial lobe to anterior end of V-shaped terminal portion, 2 mm.; width of axial lobe at the front, 2 mm.

FORMATION AND LOCALITY: A rare species, collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14704, Yale University Museum.

Protapatokephalus minutus (Raymond)

1924. *Hungaia minuta* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 442, pl. 14, fig. 1.
1925. *Hungaia minuta* RAYMOND, Vt. State Geol., 1923-1924, 14th Rept., p. 183, pl. 14, fig. 1.

More detailed study of the pygidia associated with the cranidia of *Protapatokephalus* in the lower part of the Gorge formation indicates that the writer's reference of the small pygidium, named *Hungaia minuta* (zone 2 of the Gorge formation), was incorrect. It should be referred to *Protapatokephalus,* and differs from the pygidium assigned to *P. arctostriatus* in having four instead of six pairs of marginal spines.

Genus *Diplapatokephalus* nov.

Remopleuridae allied to *Apatokephalus,* but with distinctly furrowed pleural ribs. Genotype: *Dicellocephalus finalis* Walcott.

The cranidium of *Dicellocephalus finalis* is like that of a true *Apatokephalus,* even to the possession of a row of pits inside the rim. The pygidium, however, has deeply grooved pleural ribs.

Diplapatokephalus finalis (Walcott)

1884. *Dicellocephalus finalis* WALCOTT, U. S. Geol. Surv., Mon. 8, p. 89, pl. 12, figs. 12 and 12a.
1898. *Apatokephalus finalis* BROEGGER, Nyt Mag. f. Naturvid., vol. 36, p. 184.

The cranidium of this species differs from that of European specimens of *Apatokephalus* in having much more deeply incised glabellar furrows. The pygidium has four pairs of spines, the inner pair shorter than the others.

FORMATION AND LOCALITY: The lower part of the Pogonip group, on the east slope of the ridge east of the Hamburg ridge, Eureka district, Nevada.

Diplapatokephalus multispinosus sp.nov.

(Plate 3, figure 23)

Pygidium rather flat, with a narrow, highly convex axial lobe, which tapers to a point close to the posterior end. The pleural lobes are nearly flat, and each has four furrowed ribs ending in long slender spines. Between the inner pair of these large spines are five pairs of minute ones. The axial lobe has eight rings.

MEASUREMENTS: Length of pygidium, 3 mm., width, 5.25 mm.; length of axial lobe, 3 mm.; width at the front, 1.5 mm.

This species differs from *Protapatokephalus minutus* in having numerous small spines behind the axial lobe.

FORMATION AND LOCALITY: A single well-preserved pygidium was found by the writer in the lower part of the Highgate formation on the Grandge farm, 0.5 mile south of the International Boundary and 4.5 miles north of Highgate Center, Vermont. It is No. 3826, Museum of Comparative Zoölogy.

Family DIKELOCEPHALIDAE Miller

Subfamily RICHARDSONELLINAE Raymond

Genus *Highgatea* nov.

This genus is erected to contain those dikelocephalid trilobites in which the facial sutures diverge in front of the eyes, and in which the brim is narrow, convex, and separated from the glabella by a shallow furrow. The glabellar furrows are faintly impressed in all known species. Genotype: *Highgatea laeviuscula* sp.nov.

Highgatea seems to occupy the same position with respect to *Richardsonella* that *Saukia* and its allies, the Saukiinae of Ulrich and Resser, do to the Dikelocephalinae —that is, the brim is convex rather than concave. Cephala much resemble those of *Tellerina*, except for the greater width of the brim in front of the glabella.

The associated pygidia are of a type unlike those of the Dikelocephalinae or Saukiinae. Pygidia of this type have long been known from the conglomerates at Lévis, one having been figured without a name by Billings.[5] The outstanding features are the relatively great width and the absence of the broad concave brim that is so conspicuous a feature of most dikelocephalids. The axial lobe reaches almost to the posterior margin, and the ribs are slightly or not at all furrowed. Despite these unusual features, the pygidia are not without dikelocephalid characteristics, being comparable, in brevity of the post-axial border, to those of some species of *Saukia* and *Tellerina*. The acuminate posterior prolongation of the axial lobe is a usual development in the family.

Highgatea laeviuscula sp.nov.

(Plate 1, figures 10-12)

Cranidium short, with a narrow brim, turned down at the front. Glabella large, moderately convex, parallel-sided, deflected at the front. There are only two pairs of glabellar furrows, the anterior ones so faint as to be hardly visible, the posterior pair deeper, oblique in position, neither connected with each other mesially nor with the dorsal furrows laterally. Fixed cheeks depressed; palpebral lobes large, a little behind the middle of the head, about on the level of the bottoms of the dorsal furrows.

The associated pygidium is about twice as wide as long, the posterior outline evenly convex. The axial lobe is wide at the front, pointed behind, where it reaches the posterior edge; there are five flattish rings. The pleural lobes are depressed-convex, each with four pairs of flattened ribs, the last of which are faintly delimited. Each rib has a scarcely visible longitudinal furrow. The ribs cease on reaching a flattened or slightly concave smooth border.

The cranidium is the holotype; the particular pygidium described is selected as the paratype because it is on the same fragment of rock as the cranidium.

[5] Elkanah Billings: *Paleozoic fossils, vol. 1*, Geol. Surv. Canada (1865) p. 403, fig. 382.

MEASUREMENTS: Length of cranidium, 6 mm., width at front, 6.75 mm.; width at fixed cheeks, 11 mm. Length of glabella, 5 mm., width at neck ring, 4.25 mm. Length of pygidium, 6.75 mm.; width, 15 mm.; width of axial lobe at front, 4 mm.

FORMATION AND LOCALITY: This species is fairly common in the lowest zone of the Gorge formation at Highgate Falls, Vermont, where it was collected by Schuchert. The holotype and paratype are No. 14705, Yale University Museum.

Highgatea bisinuata sp.nov.

(Plate 1, figures 13, 14)

This species is closely allied to *H. laeviuscula*. The cranidium differs in the presence of two pairs of distinctly impressed glabellar furrows, both oblique, neither reaching the dorsal furrows. Vague traces of an anterior pair are visible.

The pygidium arbitrarily assigned to this species, because of association, is of the same shape as that of *H. laeviuscula*, but differs from it in many particulars. The axial lobe has six rings, which are interrupted by a smooth area on the crest. The posterior end is bluntly pointed, and reaches the rim. The pleural lobes are depressed, concave in the outer portions, and surrounded by a narrow, striated, wire-like rim. There are five pairs of narrow ribs, which show faintly on the inner parts of the lobes, but are sharply elevated where they cross the concave border to join the rim.

MEASUREMENTS: Length of cranidium, 10.25 mm.; width at front, 12.25 mm.; width at fixed cheeks, 12 mm. Length of glabella, 8.75 mm.; width at nuchal segment, 7 mm. Length of pygidium, 5.5 mm., width, 11.5 mm. Width of axial lobe at front, 3.5 mm.

FORMATION AND LOCALITY: Schuchert collected several specimens of this species from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype and paratype are No. 14706, Yale University Museum.

Subfamily SAUKIINAE Ulrich and Resser

Genus *Saukia* WALCOTT (emend. Ulrich and Resser)

Ulrich and Resser[6] have restricted the definition of *Saukia* in such a way as to include only tuberculated Saukiinae without nuchal spines. Unfortunately, the genotype, *Dikelocephalus lodensis* Whitfield, was based upon a single free cheek, hence the genus has a very uncertain foundation. The generic characteristics are drawn from a species described by Ulrich and Resser; whether or not the genotype will prove to show the same features cannot be determined until better specimens of that species are found.

Ulrich and Resser[7] have doubted whether there is really any species of *Saukia* in New York, Quebec, or Vermont. Because they have greatly modified the definition of *Saukia* since the publication of the previous paper on the trilobites of the Gorge formation, their question as to the proper generic reference of the species which were called *Saukia stosei* and *S. dunbari* at that time is entirely justified.

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[6] E. O. Ulrich and C. E. Resser: *The Cambrian of the Upper Mississippi Valley, part 2, Trilobita, Saukiinae*, Pub. Mus. Milwaukee, vol. 12, no. 2 (1933) p. 169.

[7] *Op. cit.*, p. 218.

Saukia sp. ind.

(Plate 1, figure 15)

1924. *Saukia lodensis* RAYMOND, not Whitfield, Boston Soc. Nat. Hist., Pr., vol. 37, p. 435.
1925. *Saukia lodensis* RAYMOND, not Whitfield, Vt. State Geol., 14th Rept., 1923-1924, p. 177.

Ulrich and Resser, in their recent revision of *Saukia*, have made such a detailed separation of species that it is impossible to identify so poor a specimen as the one under discussion. Possibly it is not even generically identifiable, as the Saukiinae are now subdivided, but the strongly pustulose surface, the shape of the glabella, and the development of the glabellar furrows all agree with the conditions existing in *Saukia* as restricted.

MEASUREMENTS: Length of glabella, 12 mm.

FORMATION AND LOCALITY: A single cranidium was collected by Schuchert and Dunbar from zone 2 (the lower part of the main fossiliferous zone) of the Gorge formation at Highgate Falls, Vermont, and is No. 4746 in the Yale collection.

Genus *Saukiella* Ulrich and Resser

Saukiella dunbari (Raymond)

1924. *Saukia dunbari* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 437, pl. 14, fig. 7.
1925. *Saukia dunbari* RAYMOND, Vt. State Geol., 14th Rept., 1923-1924, p. 178, pl. 14, fig. 7.

The species described by the writer as *Saukia dunbari* (from the Gorge formation, zone 2) seems to fall within the limits of the recently erected genus *Saukiella*. It lacks the pustules of the true *Saukia*, as restricted, and the glabella seems to be longer and narrower than that of the typical *Tellerina*. Most of the brim is broken from the specimen at hand, but the furrow in front of the glabella is relatively wide. The surface is decorated with a pattern of inosculating lines and furrows, a feature supposed to be characteristic of *Tellerina*. These lines are, however, faint, and would certainly leave no impression on molds or casts in sandstone. Hence the statement that the surface of *Saukiella* is smooth cannot be accepted as positively demonstrated.

Saukiella inops sp. nov.

(Plate 1, figure 16)

1924. *Saukia stosei* RAYMOND, not Walcott, Boston Soc. Nat. Hist., Pr., vol. 37, p. 436.
1925. *Saukia stosei* RAYMOND, not Walcott, Vt. State Geol., 14th Rept., 1923-1924, p. 178.

Ulrich and Resser have pointed out that *Saukia stosei* has a small occipital spine, hence is not a *Saukia* in the restricted sense. They intimate that it cannot be assigned to any existing genus. The principal reason for identifying the Gorge specimens with *S. stosei* was the fact that the anterior border is very narrow on both. They differ, however, in that the surface of the glabella is pustulose in the latter and granulose, almost smooth, in the former. In view, then, of the uncertainty about *S. stosei*, which was figured but not described by Walcott, it seems best to erect a new species for the specimens from Vermont.

The glabella is moderately convex, almost parallel-sided, tapering but little toward the front. The three pairs of furrows are distinct, but narrow, the first two pairs short, the third united mesally as is usual in the family. The furrow in front of

the glabella is relatively wide and the elevated border very narrow. The surface is almost smooth, but, under the lens, appears distinctly granulose.

MEASUREMENTS: Length of cranidium, about 13 mm.; width of glabella at eyes, about 10 mm.

FORMATION AND LOCALITY: Two incomplete cranidia were found by Dunbar and Schuchert in the main fossiliferous zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 4729, Yale University Museum.

Genus *Stenosaukia* nov.

Saukiinae with downward-inflected anterior brim, with a narrow furrow between it and the glabella. No enlargement at the anterior end of the glabella. Genotype: *Stenosaukia irrasa* sp. nov.

Stenosaukia irrasa sp. nov.

(Plate 1, figure 17)

Cranidium small. Glabella proportionally large, rounded at the front, bounded by narrow dorsal furrows, which converge somewhat anteriorly. It stands high above the anterior brim, which is turned abruptly downward. The brim is slightly convex, separated from the glabella by a narrow furrow. The eyes are large, their anterior and posterior ends close to the glabella. The glabellar furrows are developed as usual in *Saukia*, the anterior pair hardly visible. The surface of the glabella and palpebral lobes is pustulose.

MEASUREMENTS: Length of cranidium, 3.25 mm., width, 3.25 mm.; length of glabella, 2.5 mm., width at eyes, 1.75 mm.

The most striking characteristic of this species is the general resemblance of the cranidium to that of *Apatokephalus*. The glabella is not expanded at the anterior end as it is in practically all other Saukiinae, and the elongate palpebral lobes turn so far inward at their anterior ends as to appear to embrace the posterior part of the glabella, as in *Apatokephalus*. Of more importance is the fact that the brim slopes away from the glabella, and is not in the same plane with it. In this respect the genus approaches *Ptychaspis*, but differs in the absence of a deep circumglabellar furrow, and in size and position of the eyes.

FORMATION AND LOCALITY: A single cranidium was collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14707, Yale University Museum.

Genus *Calvinella* Walcott

Calvinella obsoleta sp. nov.

(Plate 1, figure 18)

Pygidium of the usual shape for the genus, with high axial and depressed pleural lobes. The axial lobe has two distinct rings, and a third, that is faintly outlined by an obscure furrow. The posterior half of the lobe is smooth, rather obscurely triangular, merging without definite boundaries into the general surface.

The pleural lobes have two pairs of rather obscure, grooved ribs, and another slightly raised unfurrowed pair. The region behind the ribs and axial lobe is smooth and slightly concave.

MEASUREMENTS: The pygidium is 9 mm. long and 10 mm. wide. The axial lobe is 6 mm. long and 4 mm. wide at the front.

This species differs from any previously described in the smoothness of the pleural lobes, in the ribs being almost obsolete, and in the lack of a definitely

outlined triangular prolongation of the axial lobe. It most closely resembles the pygidium ascribed by Walcott to *Calvinella newtonensis* (Weller).[8]

FORMATION AND LOCALITY: The holotype is a pygidium from a loose block of Rockledge conglomerate found near the limestone lentils northwest of Georgia, Vermont; it was collected by H. W. McGerrigle. The holotype is No. 14708, Yale University Museum.

Calvinella sp. ind.

A single very imperfect specimen of a relatively large pygidium (approximately 22 mm. long) belongs either to a *Tellerina* or to a *Calvinella*. It has the strongly marked subdivision of the pleural ribs characteristic of those genera. So far as the writer knows, there is no way of distinguishing pygidia of these genera. This specimen has three ribs on the part preserved.

FORMATION AND LOCALITY: Collected by Schuchert from the lowest zone in the Gorge formation at Highgate Falls, Vermont, and now No. 14760 in the Yale University Museum.

Subfamily ILLAENURINAE Raymond

Genus *Illaenurus* Hall

Illaenurus punctatus sp. nov.

This species differs from *Illaenurus breviceps* Raymond[9] only in that the surface is covered with large puncta. The proportions, convexity, and size of the eyes are the same, but there is a striated anterior doublure, which is so placed that it can be seen from the dorsal side. This is not shown by the holotype.

MEASUREMENTS: Length of cranidium, 5 mm., width at ends of fixed cheeks, 10 mm., at palpebral lobes, about 7.5 mm.

FORMATION AND LOCALITY: Three cranidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14762, Yale University Museum.

Genus *Cholopilus* Raymond

Cholopilus magnus sp. nov.

(Plate 4, figure 31)

Cephalon and thorax unknown.

Pygidium broad, moderately convex, without concave border. Axial lobe about one third the total width at the anterior end, elongate, relatively high at the posterior end. There are two distinct rings, and obscure traces of three more. Pleural lobes without ribs.

MEASUREMENTS: Length of holotype, 10.5 mm., width, 18 mm. Length of axial lobe, 8 mm.; width at front, 7 mm., near posterior end, 4 mm.

FORMATION AND LOCALITY: A single pygidium was found in the Highgate on the Grandge farm by Thomas H. Clark, 6 feet below the contact with the Grandge. It is No. 4449 in the Museum of Comparative Zoölogy.

[8] C. D. Walcott: *Cambrian geology and paleontology, II*, Smithson. Misc. Coll., vol. 57 (1914) pl. 70, figs. 11 and 11a.

[9] P. E. Raymond: *New Upper Cambrian and lower Ordovician trilobites from Vermont*, Boston Soc. Nat. Hist., Pr., vol. 37 (1924) p. 445, pl. 14, fig. 2.

Family PTYCHASPIDAE Raymond

Genus *Diatemnus* nov.

Ptychaspidae with subquadrate glabella, two pairs of glabellar furrows, and small eyes. Genotype: *Diatemnus miculus* sp. nov.

Diatemnus seems to be closely allied to *Chariocephalus* and *Irvingella*, but differs from both in having small eyes and large fixed cheeks. The presence of small eyes suggests *Ptychaspis*, a suggestion negatived by the subquadrate form of the glabella.

Diatemnus miculus sp. nov.

(Plate 1, figure 19)

Cranidium small, depressed convex, without concave brim or thickened rim. Glabella subquadrate, with rounded anterior corners, only slightly convex, outlined by linear circumglabellar furrows. There are two pairs of narrow glabellar furrows, which meet mesially. The nuchal furrow is equally narrow and shallow.

Palpebral lobes small, situated near the anterior corners of the glabella. Fixed cheeks large, almost triangular. Brim moderately convex.

MEASUREMENTS: Length of cranidium, 3.75 mm.; length of glabella, 3 mm., width, 2.5 mm.

FORMATION AND LOCALITY: A single cranidium—the holotype—was found by Schuchert in the lowest zone of the Gorge formation at Highgate Falls, Vermont. It is No. 14709 in the Yale University Museum.

Family LIOSTRACINIDAE nov.

Opisthoparia with nearly smooth, ovate glabella, small eyes, and elevated cheeks, separated, in front of the glabella, by a median longitudinal furrow.

Genus *Liostracina* Monke

1903. MONKE, Jahrb. k. preuss. geol. Landesanst. u. Bergak., vol. 23, pt. 1, p. 114.
1913. WALCOTT, Research in China, Carneg. Inst. Washington, Pub. no. 54, vol. 3, p. 143.

Genotype and only known species: *Liostracina krausei* Monke, Middle Cambrian, Shantung, China.

Genus *Liostracinoides* nov.

Opisthoparian trilobites similar to *Liostracina*, but with the eyes farther forward, nearer the glabella, and without eye-lines. Genotype: *Liostracinoides vermontanus* sp. nov.

Liostracinoides vermontanus sp. nov.

(Plate 1, figure 20)

Glabella narrow, highly convex, surrounded by deep circumglabellar furrows, which are widest and deepest at the posterior margin. Two pairs of glabella furrows slightly indent the steep sides of the glabella, the posterior ones setting off a small pair of almost triangular basal lobes. The circumglabellar furrows are paralleled by high, curved ridges (cheek-rolls), which are separated in front of the glabella by a median furrow, giving the middle of the cranidium an agnostid appearance.

The palpebral lobes are small, situated about halfway to the front. The frontal

rim is narrow, set off from the remainder of the cranidium by a narrow groove. The surface is smooth.

MEASUREMENTS: Length of cranidium, 2.5 mm.; length of glabella, 2.2 mm., width, 1 mm.

This curious little trilobite is so remarkably like *Liostracina krausei* Monke that had they been found in formations of the same age on the same continent they would undoubtedly have been considered to belong to the same genus. But, as one is from the Mid-Cambrian of China and the other from the Upper Cambrian of Vermont, it seems best to place them in different genera. Both are imperfectly known, and it may be shown eventually that their similarities are due to parallel evolution. It is not at all probable that the resemblance to *Agnostus* has any significance.

FORMATION AND LOCALITY: A single cranidium was collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. It is No. 14710, Yale University Museum.

Liostracinoides winona (Hall)

1863. *Conocephalites winona* HALL, N. Y. State Cab., 16th Rept., p. 161, pl. 7, figs. 26-28.
1915. *Anomocarella ? winona* WALCOTT, Problems of American Geology, Yale Univ. Press, p. 225 (in list only).

The published figure of the cranidium of this species does not suggest any great resemblance to *Liostracinoides vermontanus*, but what appear to be authentic specimens are almost identical with the previous species. The palpebral lobes are smaller and farther from the glabella than would appear from Hall's figure, and a strongly elevated cheek-roll surrounds the deep circumglabellar furrow. The roll in front of the glabella is crossed by a median furrow, as is shown in the figure. The chief difference from *L. vermontanus* is that the dorsal furrows are not quite so wide, and the rim is wider.

Walcott referred this species, with doubt, to *Anomocarella*, which it resembles only slightly, for it lacks the subparallel dorsal furrows, large eyes, and eye-lines of the type (*A. chinensis* Walcott) of that genus.

FORMATION AND LOCALITY: The specimens in the Museum of Comparative Zoölogy were found in the Eau Claire formation at Dresbach, Minnesota. The plesiotype is No. 945, Museum of Comparative Zoölogy.

Family SOLENOPLEURIDAE Angelin

Genus *Aposolenopleura* nov.

Solenopleuridae closely allied to *Solenopleura*, differing chiefly in having a granular rather than a tuberculated surface. Genotype: *Aposolenopleura dunbari* sp. nov.

Aposolenopleura dunbari sp. nov.

(Plate 1, figure 21)

Cranidium minute, highly convex, with steep lateral slopes. Glabella large, high, with only faint traces of glabellar furrows. A narrow furrow separates it from the elevated, annular rim. Palpebral lobes large, about midway in the head, connected with the glabella by faintly visible eye-lines. Surface granulose.

MEASUREMENTS: Length of cranidium, 2.5 mm., width at fixed cheeks, 4 mm., width at palpebral lobes, 2.5 mm.; length of glabella, 2 mm., width, 1.25 mm.

So far as can be learned from the only part now known, this species fits perfectly well in *Solenopleura*. That typical Mid-Cambrian genus is, however, so far as the writer knows, represented in the Upper Cambrian by only one species—*Solenopleura beroe* Walcott—from Shantung,[10] a species based on a single, very small specimen, which much resembles those from Vermont, but differs in lacking eye-lines and possessing distinct glabellar furrows. It may or may not be a real *Solenopleura*, but does not help in the present problem, which is, briefly, an evaluation of the weight to be placed upon small differences. If the present specimen had been found in Mid-Cambrian strata, it would have been referred to *Solenopleura* without question. But, as it is, at this locality, associated with a close relative of *Apatokephalus*, an Ordovician trilobite, there arises the very natural suspicion as to whether it can really belong to the Mid-Cambrian genus. Perhaps the chief justification for the erection of a new genus lies in this very doubt. The writer is inclined to agree with Ulrich that more harm has been done by the reference of doubtfully identified specimens to established genera and species, than by the proposing of new names.

FORMATION AND LOCALITY: Two cranidia were collected by Schuchert in the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14711, Yale University Museum.

Genus *Hysteropleura* nov.

Solenopleuridae similar to *Bolaspis* Resser but without a boss in front of the glabella. Genotype: *Hysteropleura macgerriglei* sp. nov.

Hysteropleura macgerriglei sp. nov.

(Plate 1, figure 22)

Cranidium very convex, steep-sided, with the eyes on mounds that rise considerably above the highest part of the glabella. The nuchal segment bears a semi-erect spine, so broad at the base as to border the entire axial ring.

The glabella is oblong, moderately convex, without glabellar furrows. The brim immediately in front of it is flat, margined by an abruptly upturned annular rim. The palpebral lobes are of medium size and rise somewhat above the mound-like cheeks. The fixed cheeks are abruptly deflected at the sides, indicating that the free cheeks must have been very steep, almost vertical.

The surface is almost smooth, although there are suggestions of coarse low tubercles in places, especially in front of the eyes and on the glabella.

MEASUREMENTS: Length of cranidium, including nuchal spine, 4 mm.; width at palpebral lobes, 3.75 mm.; length of glabella, 1.5 mm.

The cranidium of this species is similar to that of *Bolaspis errata* Resser,[11] except for lack of glabellar furrows and conspicuous tubercles.

FORMATION AND LOCALITY: The holotype was collected by McGerrigle in a loose block of the Rockledge conglomerate near the lentils of limestone in the Hungerford shale northwest of Georgia Center, Vermont. Other specimens wre found in the sandy dolomite that is in place at the base of the Rockledge conglomerate, a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont. The holotype is No. 14761, Yale University Museum.

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[10] C. D. Walcott: *Research in China*, Carneg. Inst. Washington, Pub. no. 54, vol. 3 (1913) p. 168, pl. 17, fig. 17 (not figs. 14 and 14a).

[11] C. E. Resser: *Nomenclature of some Cambrian Trilobites*, Smithson. Misc. Coll., vol. 93 (1935) p. 19.

Hysteropleura errata (Resser)

1916. *Acrocephalites haynesi* WALCOTT (partim), Smithson. Misc. Coll., vol. 64, pl. 24, figs. 4 and 4a.
1935. *Bolaspis errata* RESSER, Smithson. Misc. Coll., vol. 93, p. 19.

The trilobite to which this name has been applied lacks a boss in front of the glabella and is, therefore, a *Hysteropleura* rather than a *Bolaspis*.

FORMATION AND LOCALITY: The holotype is from the Meagher limestone (Middle Cambrian) on Pole Creek, Madison Range, Montana. It is No. 602 in the Museum of Comparative Zoölogy.

Genus *Onchonotus* Raymond

Onchonotus eminens sp. nov.

(Plate 1, figures 23, 24)

Cranidium very small. Glabella smooth, extremely high, especially at the posterior end, where it overhangs the narrow, flat nuchal ring.

Palpebral lobes small, close to the glabella. Fixed cheeks small; brim narrow, with a slightly thickened rim.

MEASUREMENTS: Length of cranidium, 2.75 mm.; length of glabella, 2.25 mm., width, 2 mm., height, 1.3 mm.

This species is readily distinguished from *Onchonotus richardsoni* Walcott and *O. nasutus* Walcott by the extremely high glabella.

FORMATION AND LOCALITY: Two cranidia were collected by McGerrigle from a loose block of Rockledge conglomerate at a locality near the lentils of limestone in the Hungerford slate, northwest of Georgia Center, Vermont. The holotype is No. 14712, Yale University Museum.

Genus *Distazeris* nov.

Solenopleuridae with large subrectangular glabella, vestigial glabellar furrows, and a narrow, convex, rimless, steeply inclined brim. Genotype: *Distazeris acuta* sp. nov.

This genus is probably as closely allied to *Onchonotus* as to any described trilobite, but differs in having a convex instead of a concave brim.

Distazeris acuta sp. nov.

(Plate 1, figures 27, 28)

Cranidium very convex, with drooping cheeks. Glabella large, highly vaulted, subrectangular in outline. There are two pairs of glabellar furrows, both faint impressions on the steep sides. The palpebral lobes are small, situated opposite the anterior pair of furrows. The nuchal ring bears a short acute spine.

MEASUREMENTS: Length of cranidium, 2 mm., width, 2.25 mm.; length of glabella, 1.8 mm., width, 1 mm.

FORMATION AND LOCALITY: Collected by McGerrigle from a loose boulder of Rockledge conglomerate northwest of Georgia, Vermont. Holotype, No. 14713, Yale University Museum.

Distazeris spicata (Raymond)

1924. *Acheilus spicatus* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 424, pl. 13, fig. 12.
1925. *Acheilus spicatus* RAYMOND, Vt. State Geol., 14th Rept., 1923-1924, p. 168, pl. 13, fig. 12.

The size and position of the eyes suggest that this species should be removed from *Acheilus* to *Distazeris*, as does the presence of a roll in front of the glabella. The specimen was from zone 2 of the Gorge formation, at Highgate Falls, Vermont.

Family CEDARIIDAE nov.

Opisthoparia with smooth or faintly furrowed glabella, small free cheeks, eyes of medium size, close to the glabella. Pre-ocular facial suture nearly straight. Post-ocular suture nearly straight but reaching the posterior margin by an abrupt turn near the genal angles.

As Walcott[12] stated in his description of *Cedaria*, cranidia of this type have the appearance of Proparia, for the ends of the fixed cheeks appear to be rounded genal angles. Complete specimens, however, show the genal spines to be on the free cheek. One is tempted to speculate whether the Cedaridae are not, after all, proparians, and the spine a supragenal rather than the true genal. It is not impossible that such a spine might grow backward so as to envelop the ends of the fixed cheeks.

The finding of another trilobite with the same general structure makes it appear worth while to erect a family for the two genera in which these peculiar features are present.

Genus *Acrohybus* nov.

Opisthoparia with smooth, ill-defined, furrowless glabella, and concave brim with ill-defined, flat rim. The eyes are close to the glabella. The anterior portions of the facial sutures are directed abruptly toward the margins, and the posterior ones practically parallel the posterior margin. Genotype: *Acrohybus argutus* sp. nov.

Acrohybus differs from *Cedaria* in having only the suggestion of a rim, in the smoother appearance of the cranidium (the dorsal furrows being practically not at all impressed), and in the fact that the post-ocular portion of the facial suture does not turn forward.

Acrohybus argutus sp. nov.

(Plate 1, figure 29)

Cranidium small, highly vaulted, sloping downward from the back of the glabella to the anterior margin. Brim wide, flattened, with a trace of a furrow parallel to the margin, but with no well-defined rim. Palpebral lobes of medium size, situated about opposite the middle of the glabella. Glabella a little more than half as long as the cranidium, set off from the cheeks by its elevation above them, rather than by dorsal furrows. There are obscure traces of glabellar furrows. The nuchal furrow is deep on the fixed cheeks, but scarcely visible on the glabella. The fixed cheeks are short and wide, almost parallel-sided, rounded distally.

MEASUREMENTS: Length of cranidium, 5.25 mm., width at fixed cheeks, 9 mm., at brim, 6.75 mm., at palpebral lobes, 5 mm.; length of glabella, 3.25 mm., width at posterior end, 3 mm.

FORMATION AND LOCALITY: A single cranidium was found in a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont, by Schuchert and Prindle.

[12] C. D. Walcott: *Cambrian geology and paleontology, V, no. 3, Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75, no. 3 (1925) p. 78.

Family CERATOPYGIDAE Raymond

Genus *Paracrepicephalus* Lochman

Paracrepicephalus cf. *P. thoosa* (Walcott)

(Plate 3, figure 25)

1916. *Crepicephalus thoosa* Walcott, Smithson. Misc. Coll., vol. 64, p. 214, pl. 31, figs. 1a-k.

A single imperfect pygidium from which both spines have been broken is a representative of the *Crepicephalus texanus* group. It is narrow, with a highly elevated axial lobe, which bears four rings. The pleural lobes are smooth except for the anterior rib. It is very similar to the pygidium from the Conasauga shale shown on Walcott's plate 31, figure 1k, but is also much like the narrow one assigned tentatively to *C. texanus* and illustrated in figure 4a on his plate 30. That specimen was found in the Gallatin limestone in the Yellowstone National Park.

Measurements: Length, 3.5 mm.; length of axial lobe, 3 mm., width at front, 2.25 mm.

Formation and locality: The specimen was collected from the sandy limestone that is in place at the base of the Rockledge conglomerate at a locality 3.5 miles north of St. Albans and a mile south of Rockledge, Vermont, by Prindle, Keith, and Schuchert. It is No. 14714, Yale University Museum.

Family PLETHOPELTIDAE Raymond

Opisthoparian trilobites with steep-sided cephala with convex brims and without thickened rims. Glabella definitely outlined in primitive forms, faintly so or not at all in more specialized ones. Glabellar furrows rarely present. Eyes rather close to glabella.

Because of the apparent relationship of *Plethopeltis* to *Agraulos*, the writer[13] referred the former genus and *Stenopilus* to the Ellipsocephalidae. Ulrich has since proposed a new genus—*Plethometopus*—for a part of the species referred to *Plethopeltis*. The group may, because of the position of the eyes, be set off as a family.

Genus *Plethopeltis* Raymond

Plethopeltis incisa sp. nov.

This species agrees with *P. saratogensis* (Walcott) as restricted by Raymond,[14] in having deep dorsal furrows, but differs in lacking any traces of glabellar furrows. *P. platymarginata* Ulrich[15] has the same sort of broad brim as does the present cranidium, but the glabella of the former is proportionately wider.

Measurements: Length of cranidium, 2 mm., width at palpebral lobes, 1.9 mm., at fixed cheeks, 3 mm.; length of glabella, 1.75 mm., width at nuchal furrow, 1.2 mm.

Formation and locality: A single cranidium was found by Schuchert in the lowest zone of the Gorge formation at Highgate Falls, Vermont, and is No. 14715 in the Yale University Museum.

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[13] P. E. Raymond: *New upper Cambrian and lower Ordovician trilobites from Vermont*, Boston Soc. Nat. Hist., Pr., vol. 37, no. 4 (1924) p. 414.

[14] *Op. cit.*, p. 412.

[15] E. O. Ulrich, A. F. Foerste, and Josiah Bridge: *Systematic paleontology [of Cambrian and Ordovician formations of Ozark region, Missouri]*, Mo. Bur. Geol. Mines, 2d ser., vol. 24 (1930) p. 220, pl. 19, figs. 23 and 24.

Genus *Strotocephala* nov.

Plethopeltidae with wide cephalon, small eyes placed well forward, faintly outlined glabella, and a long nuchal spine. Genotype: *Strotocephala howelli* sp. nov.

Strotocephala, except for the nuchal spine, might at first sight be mistaken for a relative of *Illaenurus* or *Kingstonia*, but the shape of the faintly outlined glabella shows that it belongs to an entirely different group. It is probably most closely related to *Plethometopus*.

Strotocephala howelli sp. nov.

(Plate 1, figure 26)

Cranidium depressed convex, almost semicircular in outline. Glabella ovate, slightly convex, scarcely distinguishable from the remainder of the head. No nuchal or dorsal furrows present. Palpebral lobes small, situated almost opposite the front of the glabella. Occipital spine long, not much elevated.

MEASUREMENTS: Length of cranidium without spine, 2.25 mm., length of spine, 0.75 mm.; width of cranidium, 4.75 mm.

This species is unusual in its combination of a long nuchal spine with an almost smooth cranidium. The forward position of the eyes excludes it from *Plethometopus*, some species of which have a blunt nuchal spine.

FORMATION AND LOCALITY: The holotype is from the lowest zone of the Gorge formation at Highgate Falls, Vermont, and is No. 14716 in the Yale University Museum.

Family LEIOSTEGIIDAE Bradley

Kobayashi[16] has suggested the extension of the limits of this family by the addition of *Chuangia* Walcott, and possibly also *Pagodia* Walcott and *Lisania* Walcott. So far as the characteristics of the various genera involved are known, this seems a proper procedure. In view of the present uncertainty in the allocation of pygidia, most stress should be laid upon the relationships indicated by the cranidia. The family definition may be restated as follows:

Opisthoparia with long, parallel-sided or gently tapering glabella, which is separated from a narrow raised rim by a narrow furrow. Glabellar furrows faint or absent. Pygidium with few annulations.

As *Lloydia* and *Leiostegium* are so much alike that it is difficult to assign certain cranidia with confidence to one or the other, it appears that *Lloydia* should be included in the family, as well as the two genera to be described. It may be well to adopt Kobayashi's suggestion and to make two subfamilies, the genera with short pygidia—*Leiostegium* and *Chuangia*—to be included in the Leiostegiinae, and the other genera in the Lloydiinae.

Genus *Leiostegium* Raymond

Leiostegium puteatum Raymond

1924. *Leiostegium puteatum* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 455, pl. 14, figs. 12, 13, 16, 19.
1925. *Leiostegium puteatum* RAYMOND, Vt. State Geol., 14th Rept., 1923-1924, p. 194, pl. 14, figs. 12, 13, 16, 19.

[16] Teiichi Kobayashi: *Upper Cambrian of the Wuhutsui Basin, Liaotung, with special reference to the limit of the Chaumitian (or upper Cambrian) of eastern Asia, and its subdivision*, Japanese Jour. Geol. Geog., vol. 11, no. 1-2 (1933) p. 105.

This species is represented in the collection from the lower Highgate at Highgate Center, and 2 miles north of Highgate Center, Vermont. The specimens are Nos. 3838 and 3839 in the Museum of Comparative Zoölogy.

Leiostegium obtectum (Raymond)

(Plate 4, figure 29)

1924. *Asaphellus obtectus* Raymond, Boston Soc. Nat. Hist., Pr., vol. 37, p. 428, pl. 13, figs. 14 and 18.
1925. *Bellefontia obtecta* Raymond, Vt. State Geol., 14th Rept., 1923-1924, p. 171, pl. 13, figs. 14 and 18.

The fortunate discovery of a pygidium, more complete than had previously been found, at last enables the writer to assign this species to its proper genus. The presence of a narrow elevated marginal border shows that it is not an asaphid, but a *Leiostegium* of larger size and wider pygidium than any previously found at this locality. It appears to be closely allied to *Leiostegium manitoensis* Walcott, differing chiefly in having a somewhat wider axial lobe.

The new specimen is from the Highgate on the Grandge farm, which is of some interest, for the original ones were found near the base of the Grandge, immediately above the structural break in the sequence there.

Measurements: Length of pygidium, 18 mm., width, 35 mm.; width of axial lobe at front, 13 mm.

Formation and locality: The pygidia first found were from the base of the Grandge on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. The pygidium now figured (Museum of Comparative Zoölogy, No. 4434) was found by Fred B Phleger and the writer in the Highgate, about 6 feet below the base of the Grandge.

Leiostegium elongatum sp. nov.

(Plate 4, figure 30)

Cephalon and thorax unknown.

Pygidium almost three-fourths as long as wide, evenly convex, the axial lobe but little higher than the pleural ones. Axial lobe narrow, elongate, almost reaching the posterior end. At the anterior end there are four or five rather indistinct rings, which show best on exfoliated specimens. There is no concave area on the margin, the narrow rim being set off by a narrow groove.

This species differs from all described species of the genus in being more elongate.

It is difficult to distinguish between pygidia of *Leiostegium* and those of *Lloydia*. Theoretically, the axial lobe of *Lloydia* should show more rings, but, practically, that is not the case, for some pygidia from Philipsburg have but four or five rings. In most cases the elevated marginal border is distinctly wider in *Lloydia* than in *Leiostegium*, and the axial lobe also wider. Perhaps the most important difference is that the pygidia of all species of *Leiostegium* with which the writer is acquainted have a tendency toward straight sides, so that they are less smoothly rounded than those of *Lloydia*. There is just a suggestion of a triangular outline.

Measurements: The holotype is 18 mm. long, about 26 mm. wide; the axial lobe is about 7 mm. wide at the front. The other two specimens are smaller.

Formation and locality: Specimens were collected by Schuchert from the Highgate on the Grandge farm, 4.5 miles north of Highgate Center from a zone about 15 feet below the contact with the Grandge. Clark found the holotype 6 feet below the contact. It is No. 4447 in the Museum of Comparative Zoölogy.

Genus *Lloydia* Raymond

Lloydia brevis sp. nov.

(Plate 4, figure 27)

Cephalon and thorax unknown.

Pygidium short, nearly semicircular, with a wide elevated convex rim. Axial lobe prominent, about one third the total width at the front. It has two or three ill-defined rings.

This species differs from *Lloydia saffordi* in having fewer axial rings and a much shorter pygidium.

MEASUREMENTS: Length, 6.5 mm.; width, 12 mm.; length of axial lobe, 5.5 mm.; width at front, 4 mm.

FORMATION AND LOCALITY: Two pygidia were collected by Schuchert from the Highgate, about 15 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. The holotype is No. 14798 in the Yale University Museum.

Lloydia saffordi (Billings)

1860. *Bathyurus saffordi* BILLINGS, Canad. Nat., vol. 5, p. 320, fig. 24.
1861. *Bathyurus saffordi* BILLINGS, Canad. Nat., vol. 6, p. 313, figs. 1 and 2.
1863. *Bathyurus saffordi* BILLINGS, Geology of Canada, p. 239, figs. 274 a, b.
1865. *Bathyurus saffordi* BILLINGS, Pal. Foss. Canada, vol. 1, p. 259, figs. 211a, b; p. 411, fig. 393.
1913. *Lloydia saffordi* RAYMOND, Victoria Mem. Mus., Geol. Survey Canada, Bull., vol. 1, p. 66, pl. 7, fig. 16.
1925. *Lloydia saffordi* BRADLEY, Can. Field Nat., vol. 39, p. 7, pl. 1, figs. 9 and 10.

An excellently preserved pygidium of this trilobite was found in the Highgate at the Grandge farm, 0.5 mile south of the International Boundary. It is No. 3837 in the Museum of Comparative Zoölogy; it is also found in the basal Grandge formation.

Genus *Stenelymus* nov.

Leiostegiidae with strongly convex cephalon, tapering glabella with faint furrows, and long, nearly straight palpebral lobes. Genotype: *Stenelymus kobayashii* sp. nov.

Stenelymus resembles *Pagodia* in many ways, but has longer eyes, which are closer to the glabella, and a greater convexity. Its characteristics also suggest a possible descent from the Mid-Cambrian *Lisania* Walcott.[17] It differs from that genus in the absence of eye-lines and in having smaller eyes. It is also nearly related, perhaps ancestrally, to *Lloydia*, from which it differs chiefly in retaining traces of glabellar furrows and in the presence of a deep intramarginal groove.

Stenelymus kobayashii sp. nov.

(Plate 2, figure 1)

Cranidium small, highly convex, with a rather wide convex rim. Glabella unusually convex, bounded by deep dorsal furrows, which converge forward. There are two pairs of shallow glabellar furrows. The nuchal furrow was apparently deep, but the whole nuchal segment is broken off. Fixed cheeks small. At the posterior end of the glabella there is a median spot in the position occupied by a tubercle in many trilobites. The eyes must have been long and narrow.

[17] C. D. Walcott: *Research in China*, Carneg. Inst. Washington, Pub. no. 54, vol. 3 (1913) p. 163.

The steeply sloping cheeks of this little trilobite suggest relationship to some of the Solenopleuridae, but the more important features seem to indicate a relationship as outlined. It differs from *Stenelymus breviceps* (Walcott) in having the eyes closer to the glabella.

MEASUREMENTS: Length of cranidium, 4.6 mm., width at palpebral lobes, 4.5 mm.; length of glabella, 4 mm., width at posterior end, 3 mm.

FORMATION AND LOCALITY: A single specimen was found in a limestone pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont, by Schuchert and Prindle; it is No. 14717 in the Yale University Museum.

Stenelymus breviceps (Walcott)

1884. *Ptychoparia (Solenopleura) breviceps* WALCOTT, U. S. Geol. Surv., Mon. 8, p. 49, pl. 10, fig. 9.

1915. *Pagodia breviceps* WALCOTT, Problems in American Geology, Yale Univ. Press, p. 215 (in list of fossils).

It is a question whether this may not be a true *Pagodia,* but, as Kobayashi[18] has expressed the opinion that it is not, the writer includes it in *Stenelymus,* although the eyes are somewhat further from the glabella than in *S. kobayashii.*

Genus *Lecanopyge* nov.

Leiostegiidae (?) with a broad, flat, tapering glabella and with a narrow furrow and thin upturned lip, rather than a rim, in front of the glabella. Genotype: *Lecanopyge expansa* sp. nov.

Lecanopyge expansa sp. nov.

(Plate 2, figures 6-8)

Cranidium dominated by the large depressed-convex glabella, which extends almost the entire length. Traces of three pairs of glabellar furrows can be seen, but do not show as distinctly as would appear from the figure. The palpebral lobes are long and narrow, close to the glabella and near the middle of the head. The fixed cheeks are flat, with only traces of the nuchal furrow. The facial sutures turn out slightly in front of the eyes, the course being almost directly forward.

An associated hypostoma is almost identical with that of *Lloydia,*[19] but differs in having less expanded wings for connection with the doublure.

A pygidium, which is referred to this species chiefly because it is the only large one in the collection, is short and wide, with a high axial and almost flat, ribless pleural lobes. The surface, like that of the cranidium, is covered with large puncta.

MEASUREMENTS: Length of cranidium, 16 mm.; length of glabella, 14 mm.; width just in front of the nuchal furrow, 15 mm.; width of cranidium at palpebral lobes, 16 mm. Length of pygidium, 10 mm., width, 15 mm.; length of axial lobe, 6.5 mm., width, 6 mm.

The long, flattish, tapering glabella of this trilobite suggests relationship to *Lloydia,* but the rim is different, and the cheeks do not roll up from the dorsal furrows as in that genus. The pygidium is entirely different from that of *Lloydia.*

FORMATION AND LOCALITY: A rare trilobite, collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype (cranidium) is No. 14718, the hypostoma is No. 14719, and the pygidium is No. 14720 in the Yale University Museum.

[18] Teiichi Kobayashi: *op. cit.,* p. 110.

[19] J. H. Bradley, Jr.: *Trilobites of the Beekmantown in the Philipsburg region of Quebec,* Canad. Nat., vol. 39 (1925) p. 6, fig. 10.

Family STYGINIDAE Raymond

Genus *Warburgella* nom. nov.

1854. *Holometopus* ANGELIN, Pal. Scandinavica, pt. 1, p. 58.

W. E. Schevill has called the writer's attention to the fact that *Holometopus* was first used as a generic name by Milne-Edwards[20] in 1853, and hence was not available when employed by Angelin. The writer, therefore, ventures to propose the name *Warburgella*, in honor of one of Sweden's most distinguished paleontologists. Elsa Warburg[21] believes that the species commonly referred to *Holometopus* could be assigned to *Stygina*, but it is convenient to recognize both genera.[22] The genotype, of course, remains *Holometopus limbatus* Angelin, as set forth by Wiman in 1906, and definitely designated by the writer[23] in 1920.

Warburgella plana sp. nov.

(Plate 2, figure 15)

Cephalon semicircular, almost flat, with rounded genal angles. The furrowless glabella is wide in the anterior portion, constricted behind. The front end is almost straight and slopes down into a narrow concave area formed by the widening of the intramarginal furrow in this region. The cheeks are depressed-convex, separated from the rim only by a narrow furrow. The surface is broken from the cheeks of all the specimens studied by the writer, so that no traces of eyes remain, nor can the facial sutures be seen.

MEASUREMENTS: Length of cephalon, 4.5 mm., width, 7 mm.; length of glabella, 3.25 mm.; width at front, 2 mm., at neck furrow, 1.25 mm.

This species is closely allied to *Warburgella angelini* (Billings),[24] but differs in having the anterior part of the glabella more expanded, and in having the end truncated. The whole cephalon is also flatter.

FORMATION AND LOCALITY: Several cephala were found in the lower part of the Highgate formation at the Grandge farm, 0.5 mile south of the International Boundary, in Vermont. The holotype is No. 3825, Museum of Comparative Zoölogy.

Warburgella angelini (Billings)

1865. *Holometopus angelini* BILLINGS, Pal. Foss. Canada, vol. 1, pt. 3, p. 95, fig. 85.

An imperfect cephalon from the lower Highgate at the locality 0.5 mile south of the International Boundary is probably of this species, for it differs from *W. plana* in having a more elevated glabella with a rounded front. It is 2.75 mm. long, the glabella is 1.2 mm. wide at the frontal lobe and 1 mm. wide at the neck ring. This individual is No. 3834, Museum of Comparative Zoölogy.

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[20] Henri Milne-Edwards: *Mémoire sur la famille des Ocypodiens*, Ann. Sci. Nat., 3d ser., vol. 20 (1853) p. 187.

[21] Elsa Warburg: *The trilobites of the Leptaena limestone in Delarne*, Geol. Inst. Upsala, Bull., vol. 17 (1925) p. 92.

[22] P. E. Raymond: *Some trilobites of the lower middle Ordovician of eastern North America*, Mus. Comp. Zool., Bull., vol. 67 (1925) p. 67.

[23] P. E. Raymond: *Some new Ordovician trilobites*, Mus. Comp. Zool., Bull., vol. 64 (1920) p. 283.

[24] Elkanah Billings: *Paleozoic fossils, vol. 1*, Geol. Surv. Canada (1865) p. 95, fig. 85.

Family CORYNEXOCHIDAE Angelin

Subfamily *Corynexochinae* Raymond

Genus *Ucebia* Walcott

1925. WALCOTT, Smithson. Misc. Coll., vol. 75, p. 118.

Corynexochinae with subquadrate furrowless glabella and no brim. Genotype: *Ucebia ara* Walcott.

Ucebia lata sp. nov.

(Plate 2, figures 2-4)

Cephalon short, moderately convex, brimless. Glabella more than one-third the total width, smooth, furrowless. It expands somewhat toward the front. Eyes of medium size, obliquely placed, somewhat distant from the glabella. The posterior branch of the facial suture reaches the genal angle; the anterior branches from opposite sides meet beneath the front of the glabella, between it and the doublure. Free cheeks small, with rounded genal angles. The border is striated with lines similar to the terrace-lines of a doublure.

A pygidium, which may be that of this species, is short and wide, without a concave border or distinct rim. The axial lobe is large, highly elevated, reaching nearly to the posterior end. The pleural lobes are small, depressed, the outer portions curved sharply downward. This part is striated with terrace-lines like those on the free cheeks, this circumstance being the chief reason for associating this type of pygidium with the cranidia. There are no rings on the axial or ribs on the pleural lobes.

MEASUREMENTS: Holotype: length of glabella, 5.25 mm., width, 4 mm.; length of pygidium (paratype), 2.5 mm., width, 4 mm.; length of axial lobe, 2.25 mm., width at front, 2 mm. Paratype (cranidium): length, 2 mm.; width at fixed cheeks, 2.3 mm.

FORMATION AND LOCALITY: A rather common fossil in a loose boulder of Rockledge conglomerate found near the lentils in the Hungerford slate northwest of Georgia Center, Vermont. Collected by McGerrigle. A single specimen was collected from the calcareous sandstone in place at the base of the Rockledge, and another from the matrix of the conglomerate at the locality a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont. The holotype is No. 14721, and the paratypes No. 14722, Yale University Museum.

Ucebia simplex sp. nov.

(Plate 2, figure 5)

The cranidium of this species differs from that of *Ucebia ara* or *U. lata* in that the glabella is narrower at the posterior end, the fixed cheeks are wider, and there is a short, blunt nuchal spine. Superficially, it resembles *Distazeris spicata* (Raymond) but lacks the roll in front of the glabella.

MEASUREMENTS: Length of cranidium, including nuchal spine, 2 mm., width at fixed cheeks, 2.5 mm.; length of glabella, 1.5 mm., width, 1.5 mm.

FORMATION AND LOCALITY: A single cranidium was collected from the sandy limestone at the base of the Rockledge conglomerate at the locality a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont. It is No. 14724 in the Yale University Museum.

Genus *Hemirhodon* nov.

Corynexochidae with small eyes, large fixed cheeks, glabellar furrows very faint or absent, no brim or rim. Genotype: *Hemirhodon schucherti* sp. nov.

Hemirhodon appears to be closely allied to *Clavaspidella* Poulsen, but differs in having smaller eyes and much less conspicuous glabellar furrows. The cranidium is much like that assigned to *Holteria* by Walcott,[25] but the pygidium is of entirely different construction. The cranidium differs from that of *Holteria* chiefly in that the eyes are much closer to the glabella, and the anterior portion of the glabella is much wider than in that genus. The glabellar furrows of *Hemirhodon* show no tendency to unite mesially as they do in *Holteria*.

Hemirhodon schucherti sp. nov.

(Plate 2, figures 12, 13)

Glabella depressed-convex, expanded toward the front, scarcely limited by the shallow dorsal furrows. Surface smooth, either without glabellar furrows, or with one faintly impressed posterior pair. The front is incurved, without rim or brim. Eyes small, palpebral lobes depressed, nearly straight, close to the glabella, at about the mid-length. Fixed cheeks broad, depressed, featureless. Occipital furrow shallow. The anterior portion of the facial suture is close to the glabella; the posterior part diverges at an angle of about 45 degrees from the axis of the head, producing subtriangular fixed cheeks. The holotype retains three segments of the thorax. The axial lobe is less than one-third the total width, not greatly elevated. The pleura are flat, with shallow, straight grooves, and end in falcate spines.

The pygidium is semicircular, almost flat, with a short, narrow axial lobe. The axial and pleural lobes are crossed by shallow furrows, faintly delimiting three rings and about six pairs of ribs.

Measurements: Length of cranidium, 8 mm., width at tips of fixed cheeks, 11 mm.; width of glabella at front, 5.5 mm., at neck ring, 4 mm. Width of anterior segment of thorax, 11 mm., width of axial lobe of same, 4 mm. These measurements are of the holotype. Another cranidium on the same piece of rock is 12 mm. long. An associated pygidium is 7 mm. long, 13 mm. wide; its axial lobe is 4 mm. long and 2.25 mm. wide at the front.

This species and the one next to be described are closely allied. Otherwise, *Holteria problematica* (Walcott) is the only trilobite with which it might be confused.

The most remarkable feature of this trilobite is the flatness of the thorax and pygidium. There seems to be no geniculation in the thorax. The pygidium is assigned to this species rather than to the next because, like the glabella, it has only traces of furrows.

Formation and locality: Three cranidia, one with three segments of the thorax, and a single pygidium, were collected from the most westerly of the three small lentils of limestone in the upper part of the Hungerford shale northwest of Georgia Center, Vermont, by T. H. Clark, Arthur Keith, and Charles Schuchert. A single small cranidium was found by H. C. McGerrigle in a loose block of the Rockledge conglomerate near the lentil referred to, and a pygidium is present in one of the pebbles of the Rockledge conglomerate at Rockledge.

[25] C. D. Walcott: *Cambrian geology and paleontology, V, No. 3, Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75 (1925) p. 93, pl. 15, figs. 17-19.

The holotype (cranidium and part of thorax), a paratype (cranidium), and another paratype (pygidium) are Nos. 14725, 14726, and 14727, respectively, in the Yale University Museum.

Hemirhodon viator sp. nov.

(Plate 2, figures 9-11)

Cranidium similar to that of *H. schucherti* in general form, but the glabella has three pairs of faintly impressed furrows. The first pair, opposite the anterior ends of the palpebral lobes, are parallel to the posterior margin, but the other two pairs turn diagonally backward. All are short, the last pair longest and deepest.

The hypostoma, one specimen of which was, before it was cleaned, partially covered by a cranidium of an individual of this species, is typically corynexochid. The anterior expansions are wide, the posterior portion rounded in outline, with a narrow concave border. The maculae are deep, close together.

The pygidium is depressed-convex, with slightly elevated axial lobe, on which there are four rings. The pleural lobes bear six pairs of low but well-defined ribs, separated by narrow furrows.

MEASUREMENTS: As no cranidium is complete, measurements are only approximate. Length of glabella, 17 mm., width at front, 11 mm.; width of cranidium at fixed cheeks, about 22 mm. Length of large hypostoma, 10 mm., width at anterior end, about 9 mm., length of body, 7 mm. Length of pygidium, 15 mm., width, 23 mm.; length of axial lobe, 11 mm.

This species appears to be somewhat closely allied to *Clavaspidella sinupyga* Poulsen, a Lower Ozarkian ? trilobite from the Cape Frederick VII formation of Greenland. The chief similarities are in the shape of the glabella, the position of the eyes, and the width of the fixed cheeks. The differences, here considered as of generic value, are the total obliteration of the first glabellar furrows, the weakness of the remaining ones, and the shorter axial lobe of the pygidium.

FORMATION AND LOCALITY: Same as the previous species, in the Hungerford limestone lentil. The holotype (cranidium), paratype (hypostoma), and a second paratype (pygidium) are Nos. 14728, 14729, and 14730, respectively, in the Yale University Museum.

Hemirhodon minor sp. nov.

(Plate 2, figure 14)

This differs from the preceding species in its small size, narrower and more elevated glabella, wider fixed cheeks, and particularly in the position of the eyes, which are much farther from the glabella. In all these respects the cranidium is much more like that of *Holteria* than *Hemirhodon,* so much so, indeed, that for some time it was considered a *Holteria.* The glabellar furrows, of which three pairs are present, turn backward as in *Hemirhodon,* and show no tendency to cross the glabella.

Fortunately, an entire specimen of this species was collected by McGerrigle. It is not well preserved, and is a small, probably immature specimen. It suffices, however, to show that the pygidium is totally unlike that assigned by Walcott to *Holteria,* but resembles, in some respects, that of *Calvinella.*

This small specimen also shows that the free cheeks are narrow, flat toward the margin, rimless, and have flat genal spines. There appear to be eight segments in the thorax. The axial lobe is narrow.

The pygidium is too small and too poorly preserved to show details, but it appears to be semicircular, with narrow axial lobe and faint ribs.

MEASUREMENTS: The holotype, a cranidium, is 3 mm. long and 3 mm. wide at the palpebral lobes. The glabella is 1.5 mm. wide at the front and 1 mm. at the neck ring. The complete specimen (paratype) is 8.5 mm. long and 5.5 mm. wide at the back of the cephalon. The cephalon is 3.5 mm. long, and the thorax 4 mm.

FORMATION AND LOCALITY: The two specimens described were collected from a loose boulder of Rockledge conglomerate near the lentils in the Hungerford shale northwest of Georgia Center, Vermont. The holotype is Catalogue No. 14731 and the paratype Catalogue No. 14732, Yale University Museum.

Hemirhodon juvenis (Raymond)

1924. *Corynexochus juvenis* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 421, pl. 13, fig. 10.
1925. *Corynexochus juvenis* RAYMOND, 14th Rept. Vt. State Geol. (1923-1924), p. 165, pl. 13, fig. 10.

The discovery of the various species of *Hemirhodon* shows that the small cranidium, which was described by the writer in an earlier paper as a species of *Corynexochus,* may better be referred to the newly founded genus. The cranidium, which is only 2 mm. long, is very similar to that of *Hemirhodon minor.* It differs in the position of the glabellar furrows and in the shape of the glabella, which is less flattened and less expanded toward the front.

FORMATION AND LOCALITY: The holotype is from zone 2 (the lower part of the main zone) of the Gorge formation at Highgate Falls, Vermont.

Family ANDRARINIDAE nom. nov.

(Liostracidae Angelin)

Genus *Andrarina* nom. nov. *vice* Liostracus Angelin

Schevill has called the writer's attention to the fact that *Leiostracus* was first used as a generic name by Albers in 1850. This antedates Angelin's usage by about four years. So far as the writer knows, there is no other generic name available for the genotype, *Liostracus aculeatus* Angelin, and he, therefore, suggests *Andrarina.*

Genus *Stenocombus* nov.

Andrarinidae with convex brim, thickened rim set off by a deep, narrow furrow, small eyes, and without eye-lines or nuchal spine. Genotype: *Stenocombus princeps* sp. nov.

This genus appears to be closely allied to *Andrarina,* differing chiefly in having a more sharply delimited rim, a convex rather than a concave brim, and in lacking a nuchal spine. The size and position of the eyes, the course of the facial suture, and the sharply delimited but furrowless glabella are as in *Andrarina.*

Walcott[26] distinguished his *Emmrichella* from *Liostracus* in much the same terms as those used, but *Emmrichella* is characterized by large eyes, situated far back on the head.

Stenocombus princeps sp. nov.

(Plate 2, figure 17)

Cranidium moderately convex, about two-thirds as long as wide. Glabella highly convex, separated from the rather flat-topped cheeks by a narrow circumglabellar

[26] C. D. Walcott: *Research in China,* Carneg. Inst. Washington, Pub. no. 54, vol. 3 (1913) p. 134.

furrow. The nuchal furrow shows an unusual feature in that the portion that crosses the glabella is not confluent with the portions on the fixed cheeks. On the glabella the furrow is shallow but on the cheeks it is deep, and widens distally. The palpebral lobes are small, remote from the glabella, and situated at about the mid-length. The facial sutures turn abruptly outward both before and behind the eyes, indicating small free cheeks. The rim is widest and thickest in front of the glabella. The surface is nearly smooth, with some indications of pits on the cheeks.

MEASUREMENTS: Length of cranidium, 2 mm.; width at palpebral lobes, 2 mm.; length of glabella, 1.3 mm., width, 1 mm.

FORMATION AND LOCALITY: Two specimens were found in a loose block of the Rockledge conglomerate northwest of Georgia Center, Vermont. The holotype is No. 14733, Yale University Museum.

Genus *Antagmus* Resser

1936. *Antagmus* RESSER, Smithson. Misc. Coll., vol. 95, no. 4 p. 4.

Since this paper was in type, John Mason has called the writer's attention to the fact that one of his genera, which was new when he described it, has recently been published by Resser.

Antagmus schucherti sp. nov.

(Plate 4, figures 10-13)

Cranidium small, strongly tripartite, the cheeks nearly as high as the glabella. The palpebral lobes are of medium size, about midway in the head, not elevated. The anterior brim is narrow, sharply elevated. Free cheek evenly convex, extended into a short genal spine.

No complete thorax has been seen; the longest specimen has nine segments. The axial lobe is narrow, the pleura furrowed, with blunt terminations.

The pygidium is regularly rounded, the narrow axial lobe having eight rings with corresponding furrowed ribs, which reach the margin.

MEASUREMENTS: The holotype—a cranidium—is 3 mm. long and 5.5 mm. wide at the fixed cheeks. The glabella is 2 mm. long and 1.75 mm. wide at the posterior end. A pygidium (paratype) is 2 mm. long and 3 mm. wide.

The only species with which the present one can be compared is *Strenuella groenlandica* Poulsen,[27] from the Lower Cambrian of Greenland. The eyes are a little farther forward in the specimens from Vermont, and the brim is a little more abruptly upturned. For a long time the writer thought that the specimens described here belonged to the genus *Strenuella*, but B. F. Howell and Christina Lochman assure him that the other trilobites of the Hungerford shale have definite Upper Cambrian affinities. The shape of the glabella and the sharply upturned rim suggest *Millardia*. The eyes, however, are neither so high nor so close to the glabella as in that genus, and the posterior branch of the facial suture does not cut the genal angle.

FORMATION AND LOCALITY: Schuchert collected numerous cranidia, parts of the thorax, and two or three pygidia from the "Hungerford" at a locality a mile south of Parker Cobble and about a mile west of Georgia Center, Vermont. The holotype and paratypes are No. 14799 in the Yale University Museum.

[27] Chr. Poulsen: *The Cambrian, Ozarkian and Canadian Faunas of Northwest Greenland*, Meddel. om Groenland, Bd. 70 (1927) p. 253, pl. 14, figs. 24, 25.

Family ASAPHISCIDAE Raymond

Genus *Greylockia* nov.

Asaphiscidae with long narrow palpebral lobes close to the elevated glabella, and a roll between the latter and the elevated rim. Genotype: *Greylockia minuta* sp. nov.

It is unfortunate that it seems necessary to add three more to the list of almost unidentifiable genera of this type. It is to be hoped that further study will permit the elimination of some of the generic names, including the one now proposed. These genera are *Asaphiscus, Blountia, Dolgaia, Dunderbergia, Maladia, Marjumia, Modocia, Orlovia, Kaninia, Pesaia* and *Utia*. Considering the cranidia alone, all these agree in having ovate, furrowless or almost furrowless glabellae, which are separated from a well-defined rim by a short, flat, concave or convex (roll) area.

Some of these genera obviously do not belong to the Asaphiscidae, for *Marjumia* and *Maladia* have spinose pygidia. As, however, pygidia are rarely found, these genera must be considered in any attempt to identify cranidia. A grouping according to size and position of the eyes is as follows:

Large eyes, close to the glabella: *Dolgaia.*

Medium-sized eyes, close to the glabella: *Asaphiscus, Dunderbergia, Maladia,* and *Marjumia.*

Medium-sized eyes, far from the glabella: *Orlovia.*

Small eyes, far from the glabella: *Pesaia, Modocia, Utia.*

Small eyes, medium distance from the glabella: *Blountia.*

With the genera so arranged, it remains to distinguish between the cranidia in which the palpebral lobes are of medium size and close to the glabella. *Dunderbergia*[28] differs markedly from all others in that the pre-ocular facial suture extends straight to the margin instead of curving outward, then inward so as to cross the rim obliquely as in the others. *Maladia,*[29] *Asaphiscus,*[30] and *Marjumia*[31] have eye-lines and, in some specimens of the first, at least vestiges of glabellar furrows. *Maladia* may be identified by the somewhat truncated anterior end of the glabella, and *Marjumia* has somewhat longer palpebral lobes than the others, the eyes also being farther back on the cephalon.

Greylockia appears to be more nearly like *Asaphiscus* than like any of the other genera which have been discussed. The narrow elongate palpebral lobes are, however, less obliquely placed, and there are no eye-lines or traces of glabellar furrows; otherwise, the resemblance is very close.

Greylockia minuta sp. nov.

(Plate 2, figure 16)

Cranidium small, highly convex, with deep circumglabellar furrows. The roll in front of the glabella is depressed-convex, the rim thick, upturned. The palpebral lobes are elongate, the axis nearly parallel to that of the cranidium. The fixed cheeks are short and not very wide.

MEASUREMENTS: Length of cranidium, 3 mm.; length of glabella, 2.7 mm.; width, 2 mm.

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[28] C. D. Walcott: *Cambrian geology and paleontology, V, No. 3, Cambrian and Ozarkian trilobites,* Smithson. Misc. Coll., vol. 75 (1925) p. 85, pl. 16, figs. 4-7.

[29] *Op. cit.,* p. 105, pl. 16, figs. 23-26.

[30] C. D. Walcott: *Cambrian geology and paleontology, III, No. 5, Cambrian trilobites,* Smithson. Misc. Coll., vol. 64 (1916) p. 300, pl. 58.

[31] *Op. cit.,* p. 402, pl. 65, figs. 3-3b.

This species somewhat resembles *Asaphiscus ? florus* Walcott[82] from the Upper Cambrian of Blair County, Pennsylvania, but the palpebral lobes are somewhat straighter. Were it not for the fact that *A. ? florus* is figured (there is no description) as having two pairs of vestigial glabellar furrows, the writer would refer it to *Greylockia.*

Unfortunately, *Greylockia minuta* more closely resembles the associated *Coleopachys strix* than it does any of the trilobites to which it is really related. If the rim were broken from a specimen of the former, it would be difficult to decide to which genus it should be referred. The principal guide in that case would be the shape of the palpebral lobe, which is semicircular in *Coleopachys.*

FORMATION AND LOCALITY: One cranidium was collected by Prindle and Schuchert from a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont, and is No. 14734 in the Yale University Museum.

Genus *Platydiamesus* nov.

Asaphiscidae without incised dorsal furrows, glabellar furrows, or eye-lines, with a short flat or concave area in front of the glabella, and with flat palpebral lobes, which lack rims. Genotype: *Platydiamesus depressus* sp. nov.

This genus is erected for trilobites with cranidia that resemble those of *Wilberina, Dolgaia, Asaphiscus,* and some species of *Kaninia.* They are probably most closely allied to *Wilberina,* differing chiefly in having the eyes farther forward, and hence in having longer fixed cheeks, in lacking glabellar furrows, and in having a less deeply impressed nuchal furrow. The resemblance to *Dolgaia* is close, but the rather unusual flat, rimless, palpebral lobes prevent reference to that genus. *Asaphiscus* has eye-lines and a more tapering glabella. The typical *Kaninia, K. lata* Walcott and Resser,[83] has a longer glabella and deep dorsal furrows, but *K. ? speciosa,* described in the same paper,[84] has a cranidium much like those found in the Gorge formation. It differs chiefly in the larger size of the eyes.

Platydiamesus depressus sp. nov.

(Plate 2, figure 20)

Cranidium depressed-convex, with shallow dorsal furrows. Glabella low, smooth, the sides straight and convergent, the front more nearly straight than in most trilobites of this type. The area between the glabella and the rim is flat. The rim is thickened, but only slightly convex. The palpebral lobes are flat, semicircular, close to the glabella, and somewhat in front of the middle. The fixed cheeks are wide, and on them the nuchal furrow is more deeply impressed than where it crosses the glabella.

This species is similar in several respects to *Dolgaia megalops* Walcott and Resser.[85] They differ chiefly in that the palpebral lobes of the present species have no intramarginal furrow, and there is no ridge between the palpebral lobe and the dorsal furrow. *D. megalops* appears to show both these features.

The present species is much more closely allied to that next to be described.

MEASUREMENTS: Length of cranidium, 4.75 mm., width at fixed cheeks, 5.7 mm.; length of glabella, 3.8 mm., width, 3.6 mm.

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[82] *Op. cit.*, p. 392, figs. 6-6b.

[83] C. D. Walcott and C. E. Resser: *Report of the scientific results of the Norwegian expedition to Novaya Zemlya,* no. 24 (1924) p. 6, pl. 1, figs. 22-30.

[84] *Op. cit.*, pl. 1, fig. 31.

[85] *Op. cit.*, p. 11, pl. 2, figs. 41-43.

FORMATION AND LOCALITY: This species is relatively common in the lower zone of the Gorge formation at Highgate Falls, Vermont, where it was collected by Schuchert. The holotype is No. 14735 in the Yale University Museum.

Platydiamesus subtilis sp. nov.

(Plate 2, figure 21)

This species is very like *P. depressus*, but has a slightly more convex glabella, a wider brim and narrower rim, and the eyes are a little farther back.

MEASUREMENTS: Length of cranidium, 2.5 mm., width at palpebral lobes, 2.8 mm.; length of glabella, 2 mm.; width, 1.75 mm.

FORMATION AND LOCALITY: A rather rare species in the lower zone of the Gorge formation at Highgate Falls, Vermont, where it was collected by Schuchert. The holotype is No. 14736 in the Yale University Museum.

Platydiamesus inornatus (Raymond)

(Plate 2, figures 18, 19)

1924. *Asaphiscus inornatus* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 409, pl. 12, fig. 23.

1925. *Asaphiscus inornatus* RAYMOND, Vt. State Geol., 1923-1924, 14th Rept., p. 154, pl. 12, fig. 23.

This species proves to be one of the most abundant in the lowest zone of the Gorge formation, from which it was originally described. Better specimens show that the glabella is almost parallel-sided, hence it belongs with *Platydiamesus* rather than with *Asaphiscus*.

The glabella is depressed-convex, without glabellar furrows, and has a slightly impressed occipital groove. The palpebral lobes are of medium size, close to the glabella, and about midway in the head.

An associated pygidium, which may belong to this species, is short, almost semicircular, with broad, slightly concave brim. The axial lobe is short, with four rings. The pleural lobes have two pairs of ribs.

MEASUREMENTS: The specimens used as plesiotypes have the following measurements: length of cranidium, 6 mm., width at palpebral lobes, about 5 mm., at fixed cheeks, 8.25 mm. Length of glabella, 5 mm., width at neck ring, 3.75 mm.

This species differs from the two preceding in having a relatively longer and more parallel-sided glabella.

FORMATION AND LOCALITY: A fairly common species in the lower zone of the Gorge formation at Highgate Falls, Vermont, where it was collected by Schuchert. Plesiotypes are No. 14737 in the Yale University Museum.

Genus *Kaninia* Walcott and Resser

Kaninia ? platys sp. nov.

(Plate 3, figure 4)

Pygidium short and broad, nearly semicircular; border wide and concave, no rim. Axial lobe moderately convex, indistinctly annulated. The pleural lobes show the anterior half-segment, and indistinct traces of one or two pairs of furrows.

MEASUREMENTS: Length of pygidium, 6.6 mm., width, 11.5 mm.; length of axial lobe, 4.5 mm., width at front, 3 mm.

This pygidium closely resembles one of those ascribed to *Kaninia ? crassimarginata* by Walcott and Resser.[36] Were it not for this resemblance, one would natu-

[36] *Op. cit.*, pl. 1, fig. 41.

rally identify it as one of the Asaphidae. In the absence of a cranidium, the generic reference is uncertain.

FORMATION AND LOCALITY: From a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont. The holotype is No. 14738 in the Yale University Museum.

Genus *Lecanopleura* nov.

Asaphiscidae with furrowless glabella, eyes small or of medium size, close to the glabella, nuchal furrow narrow but deep, and brim flat or concave in front of the glabella. Genotype: *Lecanopleura interrupta* sp. nov.

As will be noted on inspection of the analysis of genera in the discussion of *Greylockia*, *Blountia* is the only genus the writer has been able to find that has small eyes relatively near the glabella. The present genus differs from *Blountia* chiefly in that the facial sutures turn sharply outward in front of the eyes, whereas their course is more nearly straight forward in Walcott's genus. Both have the eyes well forward, producing long fixed cheeks, and both are flat or concave in front of the glabella.

Lecanopleura interrupta sp. nov.

(Plate 3, figure 1)

Cranidium convex, with long tapering glabella, which rises above the general surface without being set off by dorsal furrows except at the back. The front of the glabella slopes gradually down to the flat area of the brim, which is bordered by a rather wide low rim. The specific name is suggested by the fact that the nuchal furrow is not continuous across the glabella, nor does it join the furrows on the fixed cheeks. The palpebral lobes are small, close to the glabella, and nearly straight.

MEASUREMENTS: Length of cranidium, 8.3 mm., width at palpebral lobes, 7 mm.; length of glabella, 7 mm., width at the neck ring, 5.5 mm.

FORMATION AND LOCALITY: The single cranidium was collected from a loose block of Rockledge conglomerate near the lentils in the Hungerford shale northwest of Georgia Center, Vermont. The holotype is No. 14739, Yale University Museum.

Lecanopleura inflecta sp. nov.

(Plate 3, figure 2)

This species is similar to the last but has a narrower flat area in front of the glabella and a highly convex rim. The nuchal furrow is continuous across the glabella but does not join the furrows on the cheeks. The palpebral lobes are both broken from the type, but another specimen shows that they are similar to those of *L. interrupta* but are a little farther from the glabella.

MEASUREMENTS: Length of cranidium, 7.2 mm., width at the palpebral lobes, 5.75 mm.; length of glabella, 5.5 mm.; width, 4.75 mm.

FORMATION AND LOCALITY: The type was collected from a loose boulder of Rockledge conglomerate found near the limestone lentils in the Hungerford shale northwest of Georgia Center, Vermont, and is No. 14740 in the Yale University Museum.

A second specimen was collected by Schuchert in the lowest zone of the Gorge formation at Highgate Falls, Vermont.

Genus *Maryvillia* Walcott

Maryvillia triangularis Raymond

(Plate 3, figure 3)

1924. *Maryvillia triangularis* RAYMOND, Boston Soc. Nat. Hist., Pr., vol. 37, p. 410, pl. 12, fig. 21.
1925. *Maryvillia triangularis* RAYMOND, Vt. State Geol., 1923-1924, 14th Rept., p. 155, pl. 12, fig. 21.

When the previous paper on the Cambrian trilobites of Vermont was written, the writer had only imperfect pygidia of this species at hand, so was not very sure of the generic reference. In the new collections, there are better specimens, one of which is figured. These agree with the type of the genus, *Maryvillia arion* Walcott,[27] in being subtriangular, with ill-defined rim, no definitely delimited ribs, and numerous narrow rings on the axial lobe. *Maryvillia arion*, which is found in the Maryville limestone (Upper Cambrian) of eastern Tennessee, has the dorsal furrows more deeply impressed than does *M. triangularis*.

MEASUREMENTS: The plesiotype is 3.5 mm. long and 4.5 mm. wide at the front.

FORMATION AND LOCALITY: The original specimens were found in the middle zone of the Gorge formation and in the overlying lower part of the Highgate formation. The one here figured was collected from a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont, and is No. 14741 in the Yale University Museum.

Genus *Dunderbergia* Walcott

Asaphiscidae with eyes of medium size near the glabella, pre-ocular facial sutures straight, widely divergent. Genotype: *Crepicephalus* (*Loganellus*) *nitidus* Hall and Whitfield.

Dunderbergia vermontensis sp. nov.

(Plate 3, figure 9)

Cranidium broad at the front, rising to a flat plateau at the level of the eyes; this, in turn, is surmounted by a large, moderately convex, furrowless glabella. The dorsal furrows are scarcely impressed except in front of the glabella. The brim is convex, sloping downward to the narrow flattened rim. The nuchal furrow is narrow but deep.

This species is similar to the type of the genus,[28] differing chiefly in that the palpebral lobes are somewhat larger in the specimens from Vermont.

MEASUREMENTS: The imperfect cranidium is about 3.5 mm. long, and 3.3 mm. wide at the palpebral lobes. Length of glabella, 2.75 mm., width, 2 mm.; width of brim, 3.7 mm.

FORMATION AND LOCALITY: A single imperfect cranidium was collected from the sandy dolomite in place at the base of the Rockledge conglomerate at a locality a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont. The holotype is No. 14742, Yale University Museum.

[27] C. D. Walcott: *Cambrian geology and paleontology, III, No. 5, Cambrian trilobites*, Smithson. Misc. Coll., vol. 64 (1916) p. 400, pl. 64, figs. 4, 4a-c.

[28] C. D. Walcott: *Cambrian geology and paleontology, V, No. 3, Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75 (1925) p. 84, pl. 16, figs. 4-7.

Genus *Idahoia* Walcott

Asaphiscidae with smooth glabella, a slightly convex roll in front of it, long eyes close to the dorsal furrows, and a well-developed occipital spine. Genotype: *Idahoia serapio* Walcott.

Idahoia minor sp. nov.

(Plate 3, figure 5)

Cranidium and glabella moderately convex, with shallow dorsal furrows. Glabella large, smooth, tapering considerably toward the front. There is a slightly convex roll of medium width in front of the glabella and a convex brim. The fixed cheek is short. Neither palpebral lobe is preserved, but from the course of the suture it is evident that they must have been close to the dorsal furrows. The occipital furrow extends across both glabella and fixed cheeks.

MEASUREMENTS: Length of cranidium without the spine, 4.5 mm.; length of glabella, 3.2 mm.; width at nuchal furrow, 3 mm.

It may seem, at first sight, to be taking some liberties with Walcott's genus to so modify its definition as to enable the writer to include this species. However, Walcott knew only two species, and the characteristic which appears to have impressed him most, the broad brim, is the sort of feature that is apt to be of specific value only. This species agrees with *I. serapio* in the course of the facial sutures, position of the eyes, shape of the glabella, lack of glabellar furrows, and presence of an occipital spine. The chief differences are the smaller size and narrower brim. Walcott's statement that *Idahoia* has no occipital furrow is contradicted by his own definition, his figures, and by specimens.[39]

FORMATION AND LOCALITY: A single imperfect cranidium was found in the sandy limestone at the base of the Rockledge conglomerate, a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont. It is No. 14743, Yale University Museum.

Family TSINANIDAE Kobayashi

Opisthoparia with smooth shields, dorsal furrows of cranidium faint or obsolete; axial lobe faintly outlined on the pygidium, which is about as long as wide. Facial sutures as in the Asaphidae.

Kobayashi[40] would include *Tsinania, Dictya, Dictyella, Camaraspis, Plethopeltis, Plethometopus, Stenopilus,* and *Leiocoryphe* in this family. It seems to the writer better to place in the family only those trilobites with long pygidia; hence, he would include only the first three of the genera listed.

Genus *Tsinania* Walcott

Tsinanidae without concave border on either shield. Glabella not outlined. Genotype: *Illaenurus canens* Walcott.

Tsinania scrinium sp. nov.

(Plate 3, figure 6)

Pygidium slightly wider than long, highly convex, with steep sides. Axial lobe long, poorly delimited by the faint dorsal furrows, and rising but little above the

[39] *Op. cit.*, p. 95, pl. 19, figs. 1 and 2.

[40] Teiichi Kobayashi: *Upper Cambrian of the Wuhutsui Basin, Liaotung, with special reference to the limit of the Chaumitian (or upper Cambrian) of eastern Asia, and its subdivision,* Japanese Jour. Geog., vol. 11, no. 1-2 (1933) p. 131-135.

general surface. An exfoliated specimen, the holotype, shows faintly about ten rings, separated by broad shallow furrows.

MEASUREMENTS: Length of pygidium, 5.5 mm., width at front, about 6 mm.

This pygidium resembles that of *T. canens* Walcott in the length of the axial lobe and in its faint rings, but appears to be somewhat narrower and more steep-sided. It is somewhat more like *T. longa* Kobayashi, but is not so nearly triangular.

This is, so far as the writer knows, the first species of the genus to be described from a North American deposit. Walcott,[41] it is true, described two species some years ago, but, as has been pointed out,[42] those trilobites have short pygidia and hence are not referable to *Tsinania*.

FORMATION AND LOCALITY: The specimens were obtained from a loose boulder of Rockledge conglomerate found near the limestone lentils in the Hungerford shale northwest of Georgia Center, Vermont, by McGerrigle. The holotype is No. 14744, Yale University Museum.

Genus *Homodictya* nov.

Tsinanidae ? with marginal suture and small eyes in front of the middle. Genotype: *Homodictya imitatrix* sp. nov.

The holotype of the species for which this genus is erected is very like specimens for which Kobayashi[43] proposed the name *Dictya*, except that the suture is niobiform rather than isoteliform. Both have characteristics strongly suggesting the Asaphidae.

Homodictya imitatrix sp. nov.

(Plate 3, figures 7, 8)

Cranidium short, wide, highly convex, sloping at the front to a concave, almost flat, rimless brim. Glabella high, smooth, delimited because it stands above the cheeks, rather than by dorsal furrows. Fixed cheeks wide, palpebral lobes of medium size, situated at about the mid-length. There are faint traces of a nuchal furrow.

An associated pygidium has a wide concave brim but no rim, a depressed-convex axial lobe with only one ring, and traces of two pairs of ribs on the pleural lobes.

MEASUREMENTS: Length of cranidium, 3.75 mm., width at palpebral lobes, 2.5 mm.; length of glabella, 2.7 mm., width, 2 mm.; length of pygidium, 5 mm., width, about 6.5 mm.

FORMATION AND LOCALITY: The holotype, No. 14745, and the paratype, No. 14746, in the Yale University Museum, were collected from a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont.

Family ASAPHIDAE Burmeister

Subfamily OGYGIOCARINAE Raymond

Genus *Metoptogyrus* nov.

Ogygiocarinae with well-defined, nearly furrowless glabella, constricted between the palpebral lobes. Brim of moderate width, flat. Genotype: *Metoptogyrus grandgei* sp. nov.

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[41] C. D. Walcott: *Cambrian geology and paleontology, III, No. 5, Cambrian trilobites*, Smithson. Misc. Coll., vol. 64 (1916) p. 227, 228.

[42] P. E. Raymond: *The Ceratopyge fauna in western North America*, Am. Jour. Sci., 5th ser., vol. 3 (1922) p. 206, 207.

[43] Teiichi Kobayashi: *op. cit.*, p. 137.

Metoptogyrus suggests *Niobe,* but differs in having a constricted, somewhat hourglass shaped glabella, similar to that of *Basilicus* or *Basiliella.* From these genera it differs in lack of glabellar furrows.

Metoptogyrus grandgei sp. nov.

(Plate 4, figure 26)

Cranidium about two-thirds as long as wide, with a flat brim of moderate width. Glabella prominent, evenly convex, rising above the general surface without the intervention of any definite furrows. There are no well-marked glabellar furrows. A backward-bowed depression crosses near the anterior ends of the palpebral lobes. Whether or not it represents a pair of confluent glabellar furrows cannot be determined from the single specimen. In the bottom of this furrow is a dark line with a ∪, convex backward, on the median line of the glabella. This shows only because the test has been removed from this portion of the head. There is also an indistinct furrow extending from the inner anterior angle of the fixed cheek nearly to the neck furrow. This may represent the last pair of glabellar furrows.

The palpebral lobes are large and flat, but poorly preserved. The facial sutures turn abruptly outward in front of the eyes, and appear to be marginal in front, although one cannot be sure, for a good deal of the margin of the brim is broken.

MEASUREMENTS: Length of cranidium, 21 mm., width at front, about 20 mm.; length of glabella, 18 mm., width at front, 11 mm.

The layer in which the cranidium just described was found has yielded several pygidia which probably belong to the same species. All are, unfortunately, poorly preserved. The best specimen is semicircular in outline with a low axial lobe, which is scarcely outlined at the posterior end. There are two axial rings and two pairs of pleural ribs, both near the anterior margin. This specimen is so badly flattened that it is an unsatisfactory one in every respect, and probably does not disclose the really important characteristics. For that reason, it is not figured. It is approximately 19 mm. long and 34 mm. wide, the axial lobe being 9.5 mm. wide at the front, and 15 mm. long. This specimen is No. 4443 in the Museum of Comparative Zoölogy.

FORMATION AND LOCALITY: The holotype was collected by Fred B Phleger and the writer from the Highgate about 10 feet below the contact with the Grandge on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4433 in the Museum of Comparative Zoölogy.

Genus *Symphysurinella* nov.

Asaphidae with unfurrowed triangular pygidia with median spine. Cranidium similar to that of *Symphysurina,* but with shorter fixed cheeks. Genotype: *Symphysurinella corlissensis* sp. nov.

The genus *Symphysurina* was proposed by Ulrich in Walcott[44] and more fully described by Walcott.[45] The cephalon, except for the dorsal furrows, is similar to that of *Symphysurus,* but the free cheeks have genal spines. The pygidium is subtriangular, and that of the type species, *S. woosteri,* has a prominent axial lobe, of which the terminal spine is a prolongation. Other species with the same type of pygidium are *S. spicata* Ulrich and *S. eugenia* Walcott. All are from Lower

[44] C. D. Walcott: *Cambrian geology and paleontology, V, No. 1, Geological formations of Beaverfoot-Brisco-Stanford Range, British Columbia, Canada,* Smithson. Misc. Coll., vol. 75 (1924) p. 37.

[45] C. D. Walcott: *Cambrian geology and paleontology, V, No. 3, Cambrian and Ozarkian trilobites,* Smithson. Misc. Coll., vol. 75 (1925) p. 108.

Ordovician formations in Wisconsin, Nevada, and western Alberta. The specimens about to be described differ from *Symphysurina* in that the dorsal furrows of the pygidium are so shallow that the axial lobe is but slightly defined. A similar species is *Symphysurina ? entella* described by Walcott[46] from the Mons of western Alberta. As Walcott did not designate a holotype for his species, and as it is highly improbable that the cranidia that he figures as belonging to *S. entella* really belong with the pygidia, the writer proposes to designate the pygidium shown in figure 22 of Walcott's plate 21 as the holotype of *Symphysurinella entella* (Walcott).

Symphysurinella corlissensis sp. nov.

(Plate 4, figures 21, 22)

Cranidium strongly convex, about two-thirds as long as wide. Glabella indistinctly outlined by shallow dorsal furrows, which converge forward until they reach the palpebral lobes, beyond which they cannot be traced. Between and behind the eyes the glabella is depressed, nearly flat; in front of them it is abruptly deflected. There is a small median pustule between the eyes. Palpebral lobes large, behind the middle of the head. Fixed cheeks short, the posterior ends of the facial sutures reaching the posterior margin behind the outer edges of the palpebral lobes. The anterior portions of the facial sutures turn but slightly outward and then inward, so that the anterior part of the glabella is only slightly wider than it is between the eyes. There is no occipital furrow or ring. Free cheeks unknown.

Pygidium short, subtriangular, with a median spine about as long as the main body of this shield. There is no anterior half-segment. The surface is smooth, the axial lobe only faintly delimited.

MEASUREMENTS: Length of cranidium, 8 mm., width at palpebral lobes, 13 mm., at fixed cheeks, about 12 mm.; width of glabella between palpebral lobes, 7.5 mm., at posterior margin, 8 mm., at widest part in front of the eyes, 8 mm. Length of pygidium, excluding terminal spine, 5 mm., width, 13 mm.; width of axial lobe at front, 5 mm.; length of spine, 5 mm.

The cranidium of this species might readily be taken for that of an *Illaenurus*, but the palpebral lobes are larger. The dorsal furrows, although faint, are more pronounced than in most species of *Illaenurus*, and, as they converge, they outline a less rectangualr glabella.

The pygidium, as already mentioned, is similar to that of *S. entella* (Walcott) but considerably shorter.

FORMATION AND LOCALITY: A single good cranidium and pygidium were collected by the writer from a pebble (numbered 3 in the collection) in the Corliss conglomerate at Corliss Ledge, about 5 miles north of St. Albans, Vermont. The pygidium (holotype) is No. 4431 and the cranidium (paratype) No. 4432, in the Museum of Comparative Zoölogy.

Genus *Symphysurina* Ulrich

Symphysurina globosa sp. nov.

(Plate 4, figures 19, 20)

Cranidium short, highly convex, the anterior end so abruptly incurved as to be invisible from the dorsal side. Dorsal furrows faint, convergent forward, disappearing before reaching the palpebral lobes. The latter are small, situated at the

[46] *Op. cit.*, p. 112, pl. 21, figs. 22-24.

mid-length. Fixed cheeks long, narrow, and triangular. The facial sutures converge in front of the eyes. There is no nuchal furrow.

MEASUREMENTS: The cranidium is 6 mm. long, about 6.75 mm. wide at the palpebral lobes, and 8 mm. wide at the fixed cheeks. The glabella is 5.75 mm. wide at the posterior margin, 5.5 mm. between the palpebral lobes, and 5 mm. wide at the widest part in front of the eyes.

This species, like the previous one, is reminiscent of *Illaenurus*, differing chiefly in the direction of the anterior portions of the facial sutures, the convergent dorsal furrows, and the more advanced position of the eyes. The anterior portion of the cranidium is more incurved and narrower than in any described species of *Symphysurina*.

FORMATION AND LOCALITY: A single cranidium was collected by the writer from a pebble (number 3 in the collection) in the Corliss conglomerate at Corliss Ledge, about 5 miles north of St. Albans, Vermont. The holotype is No. 4430 in the Museum of Comparative Zoölogy.

Symphysurina parva sp. nov.

(Plate 4, figures 16, 17)

Cranidium narrow, vaulted, strongly deflected but not incurved at the front. There are no traces of dorsal furrows. The palpebral lobes are flat, turned downward, continuing the transverse profile of the glabella. Fixed cheeks long, narrow, and flat. The facial sutures curve slightly outward, then inward, in front of the eyes.

MEASUREMENTS: Length of cranidium, 5 mm., width at palpebral lobes, 4 mm., width at posterior margin, 3 mm.

This cranidium resembles that of *Symphysurina spicata* Walcott[47] but has narrower fixed cheeks and is broader in front of the eyes.

FORMATION AND LOCALITY: A single cranidium was found by Schuchert and the writer in a pebble taken from the Corliss conglomerate at Corliss Ledge, 5 miles northeast of St. Albans, Vermont. It is No. 4437 in the Museum of Comparative Zoölogy.

Genus *Symphysuroides* nov.

Asaphidae with short smooth brimless shields, ill-defined dorsal furrows, and without pygidial spine. Genotype: *Symphysuroides latus* sp. nov.

Symphysuroides latus sp. nov.

(Plate 4, figures 23-25)

The cephalon is known only from a free cheek which indicates a short wide cephalon with rounded genal angles. The eye is at about mid-length, and is of moderate size and height. The facial suture turns outward in front of the eye, and apparently follows the anterior margin.

The pygidium is two and a half times as wide as long, evenly convex, with a wide, low, ill-defined axial lobe. There are no traces of rings or ribs.

MEASUREMENTS: The free cheek indicates that the cephalon was about 10 mm. long. The pygidium is 12 mm. long, and 30 mm. wide; the axial lobe is 8 mm. wide at the front and 10.5 mm. long.

The pygidium of this species is exceedingly like that of *Symphysurus*, but evidently both cephalon and pygidium are shorter and wider than in any species of that genus. The specimens suggest reference to the Illaenidae, but the pygidium is more

[47] *Op. cit.*, p. 113, pl. 21, figs. 13 and 14.

evenly convex, with a longer and less elevated axial lobe than is possessed by *Illaenus* and much shorter shields than any bumastid. Although the doublure of the free cheek is incomplete, there is enough of it to indicate that no epistomal sutures were present.

FORMATION AND LOCALITY: A single free cheek and three pygidia were collected by Schuchert and the writer from a pebble in the Corliss conglomerate at Corliss ledge, 5 miles northeast of St. Albans, Vermont. The holotype (pygidium) is No. 4435 and the paratype (free cheek) is No. 4436, in the Museum of Comparative Zoölogy.

Family ILLAENIDAE Hawle and Corda

Genus *Protillaenus* nov.

Illaenidae with shallow, ill-defined dorsal furrows and a flattened brim. Genotype: *Protillaenus marginatus* sp. nov.

Protillaenus marginatus sp. nov.

(Plate 3, figure 10)

Cranidium convex, wide, with backward prolonged cheeks. Glabella scarcely outlined, the dorsal furrows being visible only at the posterior end. Palpebral lobes small, far from the glabella, about the mid-length. Brim flat, deflected downward.

MEASUREMENTS: Length of cranidium, 8 mm., width, about 14 mm. Width of brim, 1.75 mm.

If the writer's diagnosis of the characteristics of this specimen is correct, this is the oldest illaenid so far discovered. It is a very unsatisfactory ancestor for the Ordovician members of the family, for it is too much like them to furnish any suggestions as to the ancestral stock. A brim is an unusual feature in this family, but one is present in some species of *Bumastus*. No true *Illaenus* is known to have a brim, so, as *Protillaenus* is allied to that stock rather than to *Bumastus*, the presence of this genus does not suggest an Ordovician age for the boulder in which it was found.

FORMATION AND LOCALITY: Three imperfect cranidia were collected by the writer from a pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont. The holotype is No. 3827, Museum of Comparative Zoölogy.

Family BATHYURIDAE Miller

Genus *Bathyurellus* Billings

Bathyurellus ? antiquus sp. nov.

(Plate 3, figure 11)

Pygidium subcircular, with concave pleural lobes and brim, on which are faint traces of two pairs of ribs. Axial lobe broad, depressed-convex, with two faint rings.

MEASUREMENTS: Length of pygidium, 5.5 mm., width, 7 mm.; length of axial lobe, 3.75 mm., width at front, 3.3 mm.

This species is described because concave pygidia are so unusual. It is certainly not a true *Bathyurellus*, but so far there is nothing to connect it with any of the cranidia in the collection.

FORMATION AND LOCALITY: Several pygidia were found by Schuchert in the lowest zone of the Gorge formation. The holotype is No. 14747, Yale University Museum.

OPISTHOPARIA of Uncertain Relationship

Genus *Heterocaryon* nov.

Opisthoparia with somewhat *Harpes*-like glabella, broad convex brim, and eyes close to the dorsal furrows. Genotype: *Heterocaryon platystigma* sp. nov.

Heterocaryon platystigma sp. nov.

(Plate 3, figure 13)

Cranidium moderately convex, with a large, highly convex glabella. The facial sutures curve outward in front of the palpebral lobes, producing a broad, slightly convex brim. The rim is depressed-convex, marked off from the brim by a shallow furrow in which is a row of small pits.

The glabella is indented at the sides by two pairs of furrows, which diverge so little from the direction of the dorsal furrows that they are merely indentations in the sides of the glabella, hardly visible from above. The posterior ones are the longer, and delimit a pair of basal lobes similar to those of *Harpes*.

The palpebral lobes are both broken away, but were evidently small and near the dorsal furrows. The fixed cheeks are wide.

The glabella has numerous low flat pustules, the rim bears a row of them, and there are a few on the brim, some of which line up in a somewhat irregular way, in front of the glabella.

MEASUREMENTS: Length of cranidium, 5 mm., width at the palpebral lobes, 3.5 mm.; length of glabella, 3.25 mm., width, 2.3 mm.

FORMATION AND LOCALITY: Three cranidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14748, Yale University Museum.

Genus *Chariocephalus* Hall

Chariocephalus peloris sp. nov.

(Plate 3, figure 12)

Cranidium small, narrow, depressed-convex. The glabella, which makes up a large part of the cranidium, is parallel-sided, rounded at the front, and has two pairs of narrow glabellar furrows. The first pair are at right angles to the dorsal furrows. The second pair are inclined a little backward and turn abruptly backward at the inner ends. The nuchal furrow is narrow, but deep. The palpebral lobe is large, the anterior end touching the glabella. Fixed cheeks small. There is a narrow convex rim in front of the glabella.

MEASUREMENTS: Length of cranidium, 2 mm., width at the palpebral lobe, 2 mm.; width of glabella, 1.5 mm.

This species is similar to *Chariocephalus whitfieldi*, the type of the genus.[48] It differs chiefly in the oblique position of the palpebral lobe and the narrowness of the anterior rim.

FORMATION AND LOCALITY: Two cranidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14749, Yale University Museum.

[48] James Hall: . . . *Fauna of the Potsdam sandstone . . . of the upper Mississippi Valley*, N. Y. State Cab., 16th Rept. (1863) p. 175, pl. 6, figs. 47-51, pl. 10, fig. 20.

Genus *Coleopachys* nov.

Opisthoparia with furrowless, tapering glabella, deep circumglabellar furrows, and a deflected brim. Eyes of medium size. Genotype: *Coleopachys strix* sp. nov.

The chief characteristic of the specimens for which this genus is erected is the combination of the unfurrowed glabella and the deflected brim. The nearest ally is perhaps *Cholopilus* Raymond,[40] which, however, has a nearly square glabella and large eyes. The two genera probably do not belong in the same family.

Coleopachys strix sp. nov.

(Plate 3, figures 14, 15)

Cranidium highly convex, dominated by the large glabella, which is surrounded by a deep circumglabellar furrow. The palpebral lobes are small, separated from the dorsal furrows by a narrow ridge. The downturned brim is narrow, without an intramarginal furrow. The fixed cheeks are wide but short, traversed by a deep nuchal furrow.

A pygidium on the same fragment as one of the cranidia may possibly belong to this species. It is approximately semicircular, nearly smooth, with only faint traces of rings and ribs, and lightly impressed dorsal furrows. The border, although not concave, is distinctly flattened. The axial lobe is not much elevated above the general surface.

MEASUREMENTS: Length of cranidium, 9 mm., width at the palpebral lobes, 12 mm.; length of glabella, 7.25 mm., width at the neck ring, 7 mm. Length of pygidium, 5 mm., width, 5 mm.; length of axial lobe, 4 mm., width at front, 2.8 mm.

FORMATION AND LOCALITY: Two cranidia and a pygidium were found by Schuchert and Prindle in a limestone pebble of the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont. The holotype (cranidium) is No. 14751, and the paratype (pygidium) is No. 14752, Yale University Museum. A cranidium was found by the writer in the matrix of the Rockledge conglomerate, 3.5 miles north of St. Albans.

Coleopachys pisum sp. nov.

(Plate 3, figure 16)

This species is represented by an imperfect cranidium, which differs from that of *C. strix* in having a wider brim, shallower circumglabellar furrow, and less elevated glabella.

MEASUREMENTS: Length of cranidium, 2.2 mm.; length of glabella, 2 mm., width, 1.8 mm.

FORMATION AND LOCALITY: Specimens were collected from the sandy dolomite at the base of the Rockledge conglomerate about a mile south of Rockledge and 3.5 miles north of St. Albans, Vermont, by Prindle, Keith, and Schuchert. The holotype is No. 14750 in the Yale University Museum.

Genus *Tostonia* Walcott

Tostonia duplicata sp. nov.

(Plate 3, figure 17)

Cranidium depressed-convex, with a low glabella set off by shallow dorsal furrows. The palpebral lobes are long, close to the glabella. The slightly convex brim is

[40] P. E. Raymond: *New Upper Cambrian and Lower Ordovician trilobites from Vermont*, Boston Soc. Nat. Hist., Pr., vol. 37 (1924) p. 447.

not so wide as the rim. The glabella has two pairs of well-developed furrows, which do not meet the dorsal furrows, and a faint anterior pair.

A pygidium which probably belongs with this species has a high axial and flattened pleural lobes, and about seven pairs of short marginal spines. The pleural ribs are faint; apparently, there are four on each side.

MEASUREMENTS: Length of cranidium, 3 mm., width at the palpebral lobes, 2.3 mm.; length of glabella, 2.3 mm., width, 1.5 mm. Length of pygidium, 2 mm., width, 3.25 mm.

This species is closely allied to the type of the genus, *T. iole* Walcott,[50] but differs in having longer eyes and a wider rim. The ribs of the pygidium are much less distinct.

FORMATION AND LOCALITY: A few cranidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14753, Yale University Museum.

Tostonia unisulcata sp. nov.

(Plate 3, figure 18)

The cranidium of this species is similar to that of *T. duplicata*, differing chiefly in having only one pair of glabellar furrows.

MEASUREMENTS: Length of cranidium, 4.2 mm., width at palpebral lobes, 4 mm.; length of glabella, 3.2 mm., width, 2.3 mm.

FORMATION AND LOCALITY: A single cranidium was found by Schuchert in the lowest zone of the Gorge formation at Highgate Falls, Vermont, and is No. 14755 in the Yale University Museum.

Tostonia trunca (Clark)

1924. *Solenopleura trunca* CLARK, Bull. Am. Paleont., vol. 10, no. 41, p. 26, pl. 4, fig. 1.

This species, from the Upper Cambrian boulders in the conglomerate at Lévis, Quebec, differs from *T. duplicata* in having much fainter and narrower glabellar furrows.

Genus *Bynumia* Walcott

1925. WALCOTT, Smithson. Misc. Coll., vol. 75, p. 78.

Opisthoparia with nearly smooth cranidium, faintly outlined ovate glabella, and depressed-convex brim without rim. Genotype: *Bynumia eumus* Walcott.

The most striking feature of the trilobites in this genus is the subtriangular shape of the cranidium, the portion in front of the glabella being narrow. The general expression is that of some species of *Megalaspis*, but the convexity of the brim negates reference to that group. The outline of the glabella precludes any suggestion of relationship to *Kingstonia* or *Illaenurus*. It is probably a terminal member of some unidentified lineage.

Bynumia leptogaster sp. nov.

(Plate 3, figures 19, 20)

Cranidium nearly smooth, highly arched at the posterior end, depressed-convex at the front. Glabella ovate, not greatly elevated above the general surface, out-

[50] C. D. Walcott: *Cambrian geology and paleontology, V, No. 3, Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75 (1925) p. 117, pl. 18, figs. 10-14.

lined by the dorsal furrows only at the posterior end. There are no traces of glabellar or nuchal furrows.

The palpebral lobes are long and narrow, situated close to the glabella at about the mid-length.

An associated pygidium, which may belong to this species, is about three-fourths as long as wide, evenly convex, without concave border. The axial lobe is long, tapers rapidly in the anterior half, the course of the dorsal furrows producing a biconcave outline. There are no traces of rings or ribs.

MEASUREMENTS: Length of cranidium, 11 mm., width at fixed cheeks, 11 mm., width at palpebral lobes, about 7 mm. Length of pygidium, about 8 mm.

This species differs from *Bynumia eumus* Walcott in having a less distinctly outlined glabella, and in the profile of the cranidium. This is evenly convex in *B. eumus*, but is slightly concave in front of the glabella in this species.

FORMATION AND LOCALITY: From a limestone pebble in the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont. Collected by Prindle and Schuchert. Holotype (cranidium) and paratype (pygidium) are Nos. 14756 and 14757, respectively, in the Yale University Museum.

Genus *Perischodory* nov.

Opisthoparia with rather straight-sided pygidia with a single pair of lateral spines, which are extensions of the anterior segment. Genotype: *Perischodory grandgei* sp. nov.

Perischodory grandgei sp. nov.

(Plate 4, figure 28)

Cephalon and thorax unknown.

Pygidium about twice as wide as long, straight-sided, rounded posteriorly. Axial lobe elongate, narrow, high at the posterior end, with five rings. Pleural lobes ribless, highly convex, surrounded by a narrow convex rim.

MEASUREMENTS: Length, 8 mm.; width at anterior end, disregarding spines, about 15 mm. Width of axial lobe at front, 3 mm., length, 7 mm.

Perischodory resembles *Housia* Walcott[51] in having a single pair of spines on the first segment of the pygidium. The segment is not, however, semidetached as in that genus, and other features, such as the outline and the length of the axial lobe, are entirely different.

Chosenia laticephala Kobayashi[52] from the Lower Ordovician of Korea is a trilobite with a somewhat similar pygidium. There is, however, no evidence that the two trilobites are related. The pygidium of *Proceratopyge nathorsti* Westergård[53] is also similar, especially in the outline of the part behind the spines. The pygidia of all the species with spines on the anterior angles appear to be broader than that of *Perischodory grandgei*.

FORMATION AND LOCALITY: Clark found the holotype in the Highgate immediately below the contact with the Grandge on the Grandge farm, 4.5 miles north of Highgate Center, Vermont, and Schuchert found another 15 feet below the contact. The holotype is No. 4444 in the Museum of Comparative Zoölogy.

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[51] *Op. cit.*, p. 93.

[52] Teiichi Kobayashi: *The Cambro-Ordovician formations and faunas of south Chosen; Paleontology, Part I, middle Ordovician faunas; II, lower Ordovician faunas*, Imp. Univ. Tokyo, Jour. Faculty Sci., vol. 3, pt. 9 (1934) p. 567, pl. 8, figs. 8-11.

[53] A. H. Westergård: *Sveriges Olenidskiffer*, Sveriges Geol. Undersökning, ser. Ca, no. 18 (1922) pl. 2, figs. 3-5.

Genus *Apedopyanus* nov.

Opisthoparian trilobites allied to *Alokistocare*, but with larger free cheeks, eyes nearer the glabella, and without a wide concave brim. Genotype: *Apedopyanus parkeri* sp. nov.

Apedopyanus parkeri sp. nov.

(Plate 4, figure 18)

Entire test ovate, the cephalon much wider than the thorax, the latter tapering to a small pygidium.

Cephalon about three times as wide as long, with large smooth free cheeks, which are extended into genal spines. Glabella short, convex, with, apparently, two or possibly three pairs of furrows on the slopes. In front of the glabella is a low boss. The eyes are so badly flattened as to be obliterated, but they appear to have been of moderate size, near the dorsal furrows and behind the middle of the head.

The posterior portion of the facial suture is nearly straight, extending obliquely back to the margin in such a way as to produce a wide triangular fixed cheek. The course in front of the eye is obscure, but it is apparently first nearly straight forward, then slightly outward, curving inward again inside the margin.

The thorax appears to have eleven segments, with grooved pleura, but the preservation is so bad that no details can be made out.

The pygidium is extremely poorly preserved, but is apparently short and rounded, with about three rings and three pairs of ribs.

MEASUREMENTS: Length, 9 mm.; length of cephalon, 3.5 mm., width, about 10 mm.; length of glabella, 2 mm., width 1.75 mm. Width of axial lobe, at front of pygidium, 1 mm.

This species apparently is rather closely allied to *Alokistocare pomona* Walcott,[54] but has a shorter glabella and fewer thoracic segments. The writer is inclined to think that these species are congeneric, in spite of the obvious differences.

FORMATION AND LOCALITY: The holotype was collected by Schuchert in the basal Hungerford slate, a mile south of Parker Cobble and about a mile west of Georgia Center, Vermont. It is No. 14800 in the Yale University Museum.

Order PROPARIA Beecher

Family PUNCTULARIIDAE nov.

Proparia with elongate, ovate, transversely furrowed glabella. The whole surface is set with small, irregularly arranged circular pits.

Genus *Punctularia* nov.

Punctulariidae with small eyes, narrow free cheeks, and rounded genal angles. Genotype: *Punctularia ornata* sp. nov.

Punctularia ornata sp. nov.

(Plate 3, figure 21)

Cranidium depressed-convex, evenly arched. The elongate glabella is outlined by dorsal furrows, which are deep and wide at the posterior end of the cephalon,

[54] C. D. Walcott: *Cambrian geology and paleontology, III, No. 3, Cambrian trilobites*, Smithson. Misc. Coll., vol. 64 (1916) p. 186, pl. 25, fig. 6.

but which become faint where they meet at the front. Three pairs of glabellar furrows, all directed straight inwardly, can be made out, although they show only as shallow, smooth-bottomed grooves on the pitted surface. The first, which are far forward, are no more than indentations of the sides of the glabella; the second are opposite the front of the palpebral lobes; and the third, the only ones that are at all distinct, are a short distance back of the posterior end of the palpebral lobe. They extend only a short distance onto the surface of the glabella.

There is a narrow convex area (roll) between the glabella and the rim, which is wide and convex, but is turned down rather than upward. The palpebral lobes are small, close to the dorsal furrows, and about midway in the length. The fixed cheeks are large and long, but not very wide. The genal angles are broadly rounded, the post-ocular branch of the facial suture reaching the lateral margin well in front of the angle. The occipital furrow is broad, and turns forward at the genal angle.

This species does not appear to be related to any of the few Cambrian Proparia hitherto described. It is possible that the course of the post-ocular portion of the facial suture had the same curious looping as in the Cedariidae, and that *Punctularia* is an opisthoparian, but this seems unlikely.

MEASUREMENTS: Length of cranidium, 2.3 mm., width at fixed cheeks, 3.3 mm.; length of glabella, 2 mm., width, 1 mm.

FORMATION AND LOCALITY: Two cranidia were collected by Schuchert from the lowest zone of the Gorge formation at Highgate Falls, Vermont. The holotype is No. 14758, Yale University Museum.

Family CEPHALOCOELIIDAE nov.

Proparia in which the broad, inflated, smooth glabella makes up the greater part of the cephalon.

Genus *Cephalocoelia* nov.

Cephalocoeliidae without glabellar furrows. Genotype: *Cephalocoelia ovoides* sp. nov.

Cephalocoelia ovoides sp. nov.

(Plate 3, figure 22)

Cranidium small, highly convex, with short genal spines. The glabella is very plump, almost circular, set well above the cheeks, overhanging the front, as in *Phacops*. There are no traces of glabellar furrows. The nuchal segment is rather wide and flat, limited by a deep furrow, which does not extend onto the fixed cheeks.

No palpebral lobe can be definitely seen. It is possible that the animal was blind, but the outline of the cheeks, and the absence of a rim from them, suggest that free cheeks were originally present.

MEASUREMENTS: Length of cranidium, 3.2 mm., width at (supposed) palpebral lobes, 3 mm.; width at fixed cheeks, 4 mm.

The writer knows of nothing with which this trilobite can be compared unless it be some of the latest and most specialized of Devonian phacopids.

FORMATION AND LOCALITY: The single cranidium was collected by Prindle and Schuchert from the matrix of the Rockledge conglomerate at Rockledge, 4.5 miles north of St. Albans, Vermont, and is No. 14659 in the Yale University Museum.

Family CHEIRURIDAE Salter

Subfamily CHEIRURINAE Raymond

Genus *Pilekia* Barton

Pilekia apollo (Billings)

(Plate 4, figure 7)

1860. *Cheirurus apollo* Billings, Canad. Nat., vol. 5, p. 322, fig. 28.
1863. *Amphion cayleyi* Billings, Geol. Canada, p. 239, fig. 277 (not 276).
1865. *Cheirurus apollo* Billings, Pal. Foss. Canada, vol. 1, p. 413, fig. 397.
1865. *Amphion cayleyi* Billings, Pal. Foss. Canada, vol. 1, p. 413, fig. 398 (not 399).
1913. *Pseudosphaerexochus apollo* Raymond, Geol. Surv. Canada, Victoria Mem. Mus., Bull. 1, p. 36-38, pl. 4, figs. 1 and 2.
1916. *Pilekia apollo* Barton, Washington Univ. Studies, vol. 3, pt. 1, p. 113, figs. 7a and 7b.

A well-preserved cranidium is figured because it shows, more clearly than any specimen previously known, the form of the cheek and the position of the eye. It is from the Highgate on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 3832 in the Museum of Comparative Zoölogy; H. W. McGerrigle and the writer, collectors. Another specimen was found by Schuchert and Dunbar at a locality 2 miles north of Highgate Center.

Genus *Metapliomerops* Kobayashi

Metapliomerops extenuatus (Raymond)

1924. *Pilekia extenuata* Raymond, Boston Soc. Nat. Hist., Pr., vol. 37, p. 457, pl. 14, figs. 17 and 20.
1925. *Pilekia extenuata* Raymond, Vt. State Geol., 14th Rept., 1923-1924, p. 198, pl. 14, figs. 17 and 20.

Kobayashi[55] has recently discussed the cheirurids of the lowest Ordovician strata and correctly points out that *P. extenuata* is not a real *Pilekia*. Unfortunately, there is some question as to the association of cephalon and pygidium, and it is upon pygidial characteristics that the genera must be separated. The cranidium could be distinguished from that of *Pilekia* only on the basis of the more elongate glabella, which hardly seems a characteristic of generic importance. The pygidium, however, differs markedly from that of *Pilekia* in having a fifth and possibly a sixth pair of vestigial spines in addition to the slender anterior ones. The pleural lobes bear grooves instead of narrow linear furrows, and there is no suggestion of grouping of the lateral spines in pairs as in *Pilekia*.

The writer cannot agree with Kobayashi in regard to the relationships of these genera, because he sees no close alliance either with *Protopliomerops* or with *Pliomerops* itself. *Protopliomerops* Kobayashi and *Strotactinus* Bradley[56] both have *Pliomerops*-like pygidia.

These forms may be ancestral to *Pliomerops*. Of the two, *Strotactinus* seems the more probable progenitor, for it has the less diagonally directed posterior glabellar furrows of the two, and the basal lobes are the more nearly square.

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[55] Teiichi Kobayashi: *The Cambro-Ordovician formations and faunas of south Chosen; Paleontology, Part I, middle Ordovician faunas; II, lower Ordovician faunas*, Imp. Univ. Tokyo, Jour. Faculty Sci., vol. 3, pt. 9 (1934) p. 568.

[56] J. H. Bradley, Jr.: *Trilobites of the Beekmantown in the Philipsburg region of Quebec*, Canad. Nat., vol. 39 (1925) p. 8, pl. 1, figs. 1 and 2.

A tentative diagnosis of *Metapliomerops* may be:

Cheirurinae with narrow cephalon, narrow tapering glabella, four pairs of curved pygidial spines and one or two pairs of vestigial ones. Genotype: *Pilekia extenuata* Raymond.

No new localities for this Highgate species have been found since the time of the original description.

Metapliomerops latidorsatus sp. nov.

(Plate 4, figure 9)

This name is suggested for a pygidium that is very similar to that of *M. extenuatus*, differing chiefly in having a wider axial lobe and shorter and less slender marginal spines. The axial lobe has only four instead of five annulations, the boss at the end being unusually long and smooth.

MEASUREMENTS: Length, 7 mm., width, 14 mm.; length of axial lobe, 7 mm., width at front, 4 mm.

FORMATION AND LOCALITY: A single pygidium was collected by Fred B Phleger and the writer from the Highgate on the Grandge farm, 4.5 miles north of Highgate Center, Vermont, and is No. 4438 in the Museum of Comparative Zoölogy.

Genus *Strototropis* nov.

Cheirurinae with sub-rectangular glabella, eyes close to the dorsal furrows and far forward, and three pairs of glabellar furrows. Genotype: *Strototropis laeviuscula* sp. nov.

Strototropis laeviuscula sp. nov.

(Plate 3, figure 24)

Cephalon about three times as long as broad, the fixed cheeks terminating in large, divergent genal spines. The glabella, which is about one-fourth the total width, bears three pairs of long, sub-parallel, nearly equal furrows, the first of them entering the dorsal furrows near the front. The palpebral lobes are large, close to the dorsal furrows, the anterior end of the lobe being opposite the outer end of the first glabellar furrow. The free cheeks, which are missing, were evidently small. The suture turns abruptly outward in front of the palpebral lobe.

MEASUREMENTS: Length of cranidium, 10 mm., width at genal angles, disregarding the genal spines, 28 mm. Length of glabella, 9.5 mm., width, 6.75 mm.

This species might have been referred to Kobayashi's[87] *Parapilekia* so far as any positive evidence is concerned. The only difference noted by the writer is that the glabella is subrectangular instead of ovate. The pygidia of the three known species of *Parapilekia—P. speciosus* (Dalman), *P. bohemicus* (Ružička) and *P. oležnaensis* (Ružička)—are characterized by four pairs of spines. It is not known whether any of the pygidia found at the Grandge farm belong with the cephalon here described, but all specimens so far studied have five pairs of spines. As the oval form of glabella is associated with a pygidium with four pairs of spines in both *Pilekia* and *Parapilekia*, it seems probable that the species with rectangular glabella should be referred to another genus.

FORMATION AND LOCALITY: A single well-preserved cranidium was collected by McGerrigle and the writer from the Highgate on the Grandge farm, 4.5 miles north

[87] Teiichi Kobayashi: *The Cambro-Ordovician formations and faunas of south Chosen; Paleontology, Part I, middle Ordovician faunas; II, lower Ordovician faunas*, Imp. Univ. Tokyo, Jour. Faculty Sci., vol. 3, pt. 9 (1934) p. 570.

of Highgate Center, Vermont. It is No. 3824 in the Museum of Comparative Zoölogy.

Strototropis elevata sp. nov.

(Plate 4, figure 8)

Cranidium highly vaulted, the cheeks turned abruptly down at the sides. Glabella convex, with a median keel. The first two pairs of glabellar furrows are subparallel, directed slightly backward. The third pair turn sharply back toward the nuchal furrow. The palpebral lobe is far forward and close to the glabella, but the anterior part of the head is too much damaged to show the course of the facial suture. The genal angles are also broken so that the presence or absence of spines cannot be determined.

MEASUREMENTS: The cranidium was probably about 6 mm. long and 10 mm. wide. The glabella is 5.25 mm. long (without the nuchal ring) and 3.5 mm. wide.

It is doubtful if this species really belongs to the genus *Strototropis*, but the only specimen is too poorly preserved to serve as the type of a new genus. It somewhat resembles *Cheirurus eryx* Billings,[58] but has a more nearly rectangular glabella.

FORMATION AND LOCALITY: The holotype was collected by Fred B. Phleger and the writer from the Highgate on the Grandge farm, 4.5 miles north of Highgate Center, Vermont and is No. 4439 in the Museum of Comparative Zoölogy.

Genus *Leiostrototropis* nov.

Cheirurinae similar to *Strototropis*, but without the anterior pair of glabellar furrows. Genotype: *Leiostrototropis phlegeri* sp. nov.

Leiostrototropis phlegeri sp. nov.

(Plate 4, figure 14)

Cranidium moderately convex, dominated by the glabella, which is high, nearly semicircular in transverse section, and parallel-sided. There is no trace of the anterior pair of glabellar furrows, the second pair are narrow and shallow, and only the last are deeply impressed. The palpebral lobe is far forward and near the dorsal furrow. The anterior portion of the facial suture appears to extend straight forward to the margin, but the specimen is badly damaged in this part. The free cheeks were obviously small.

MEASUREMENTS: The cranidium is about 8 mm. long and 19 mm. wide (neglecting the genal spines). The glabella is 7 mm. long and 5 mm. wide.

This and the next species to be described are the only cheirurids with which the writer is acquainted in which the anterior pair of glabellar furrows is completely absent. They are short and shallow in several genera, and possibly absent from some specimens of *Sphaerocoryphe*. Most simple cheirurids of the type of *L. phlegeri* have deeply impressed furrows.

FORMATION AND LOCALITY: A single cranidium was collected by T. H. Clark from the Highgate, 6 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4446 in the Museum of Comparative Zoölogy.

Leiostrototropis laevis sp. nov.

(Plate 4, figure 15)

This species differs from *L. phlegeri* in having a wider cranidium with rounded instead of spinose genal angles, and in the absence of pitting on the fixed cheeks.

[58] Elkanah Billings: *Paleozoic fossils. vol. 1*, Geol. Surv. Canada (1865) p. 413, fig. 399.

The smoothness of the cheeks is an unexpected feature, suggesting an alliance with *Pliomera*. The eyes are situated as in *L. phlegeri*, but the posterior portion of the facial suture, instead of being bowed forward, is almost straight.

It is probable that a new genus should be erected for this species, but the glabella is so much like that of *L. phlegeri* that it has been left in the same genus.

MEASUREMENTS: The cranidium is 5 mm. long, 10 mm. wide; the glabella is 4.75 mm. long and 3 mm. wide.

FORMATION AND LOCALITY: The holotype was collected by T. H. Clark from the Highgate, 6 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4445 in the Museum of Comparative Zoölogy.

Subclass OSTRACODA Latreille

Family LEPERDITIDAE Jones

Genus *Isochilina* Jones

Isochilina puteata sp. nov.

(Plate 4, figure 5)

Left valve roughly rectangular, highly convex, about three-fourths as wide as long. The surface is pitted with large puncta except in the region of the muscle-scar, which is situated slightly in front of the mid-length and near the hinge. In front of the scar, there is a scarcely visible eye-spot.

MEASUREMENTS: The holotype is 4 mm. long, 3 mm. wide, and the hinge is 3 mm. long.

This species is very like *Isochilina seelyi* (Whitfield),[89] differing chiefly in having a less markedly flattened margin and a less oblique outline.

FORMATION AND LOCALITY: Two valves were collected by Thomas H. Clark from the Highgate limestone, 10 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. The holotype is No. 4452 in the Museum of Comparative Zoölogy.

Isochilina tenuifilum sp. nov.

(Plate 4, figure 2)

Left valve highly convex with narrow and indistinct flattened margin, which is visible only at the anterior and posterior ends. There is no eye-spot, and the muscle-scar is small and inconspicuous. Low on the valve, back of the middle, is a small, nearly circular, roughened area from which narrow grooves radiate. Similar striations radiating from muscle-scars have been seen on the interiors of ostracod shells. This, however, is a surface phenomenon, and is not connected with the muscles. There is only one specimen, and it may be that these markings were produced by some parasitic organism.

MEASUREMENTS: The holotype is 4 mm. long, 2.75 mm. wide, and the hinge is 3 mm. long.

This species resembles *I. seelyi* in outline, but is less conspicuously punctate and has a less flattened margin.

[89] R. P. Whitfield: *Observations on some imperfectly known fossils from the Calciferous sand-rock of Lake Champlain and descriptions of several new forms.* Am. Mus. Nat. Hist., Bull., vol. 2 (1887), p. 60, pl. 13, fig. 6.

FORMATION AND LOCALITY: A single valve was collected by Thomas H. Clark from the Highgate limestone, 10 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4451 in the Museum of Comparative Zoölogy.

Isochilina eximia sp. nov.

(Plate 4, figure 3)

Right valve about four-fifths as wide as long, moderately convex, with a narrow flattened margin. The eye-spot is conspicuous and just behind it is a low mound which probably represents the muscle-scar. An extremely shallow sulcus extends from between these two elevations obliquely backward to the hinge. This furrow is so slightly impressed that it can be seen only with proper illumination. The surface is smooth, hardly any puncta being visible.

MEASUREMENTS: The holotype is 2.5 mm. long, 1.9 mm. wide, and the hinge is 1.9 mm. long.

This species is of the same general type as *Isochilina gregaria* (Whitfield), but the sulcus is not so well developed.

FORMATION AND LOCALITY: A single valve was collected by Thomas H. Clark from the Highgate limestone, 10 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4454 in the Museum of Comparative Zoölogy.

Isochilina bilabiata sp. nov.

(Plate 4, figure 4)

This species differs from *I. eximia* chiefly in having a less conspicuous muscle-scar and more definitely flattened margins at the anterior and posterior ends.

MEASUREMENTS: The holotype is 3 mm. long, 2.1 mm. wide, and the hinge is 2 mm. long.

FORMATION AND LOCALITY: A single valve was collected by Thomas H. Clark from the Highgate limestone, 10 feet below the contact with the Grandge, on the Grandge farm, 4.5 miles north of Highgate Center, Vermont. It is No. 4453 in the Museum of Comparative Zoölogy.

STRATIGRAPHIC SIGNIFICANCE OF THE FOSSILS

FOSSILS OF THE HUNGERFORD SHALE

The fossils described in the preceding pages are so fragmentary that the years of study devoted to them can be rewarded only if it can be shown that they have significance as indicators of the relative ages of the strata in which they were found.

The writer has described only two species of trilobites from the Hungerford shale. *Apedopyanus parkeri* appears to be allied to *Alokistocare*, a genus whose range is from the upper part of the Lower Cambrian through the Middle Cambrian. *Antagmus schucherti* seems to be allied to the Lower Cambrian *Strenuella*. It should be noted that these fossils were not found in the typical Hungerford shale at the Hungerford Brook, but at a locality west of Georgia Center which has been the subject of much difference of opinion. The writer infers from the nature of the

trilobites that the strata from which they were taken are not the Hungerford shales, but belong to a zone high in the Lower Cambrian. Schuchert does not share this view, which is here expressed as a purely personal opinion.

The lentils of limestone in the Hungerford shale have so far yielded no fossils other than the two species, *Hemirhodon schucherti* and *H. viator*, described in this paper. These trilobites are most closely related to *Clavaspidella*, which Poulsen described from boulders found at Cape Frederick VII in northwestern Greenland. He referred these boulders, with question, to the Lower Ozarkian. In them, he found also *Prosymphysurus kochi* Poulsen, *Ptychoparella brevicauda* Poulsen, and a pygidium somewhat similar to that of *Paracrepicephalus*. Poulsen [60] stated that he thought the advanced features exhibited by the trilobites indicated a Lower Ozarkian, rather than an Upper Cambrian, age.

The writer is inclined to think that the trilobites are not so advanced as Poulsen supposed, and that *Hemirhodon* is more likely to prove to be a descendant than an ancestor of *Clavaspidella*, for the glabellar furrows are much less deeply impressed and the eyes are nearer the glabella. *Ptychoparella* is of a type common in the Mid-Cambrian.

Poulsen's determination was probably largely influenced by the similarity of *Prosymphysurus* to *Symphysurus*. Were the cranidium alone known, this similarity might be due to relationship. The pygidium, however, is not of the *Symphysurus* type. Therefore, the writer believes that the Cape Frederick VII formation may prove to be of late Middle or early Upper Cambrian age. The presence of *Hemirhodon* in the lentils is, according to this interpretation, not out of consonance with the testimony of the trilobites found in the shale.

Since writing the foregoing, the writer has come upon Resser's recent statement that the Cape Frederick VII formation "seems clearly to represent a portion of the Stephen formation and is therefore Middle Cambrian." [61] He, thus, shares the opinion, which the writer had reached independently. His argument is, however, somewhat weakened by the fact that *Athabaskia* may not be, as he supposed, the same as *Clavaspidella*. No *Athabaskia* with four pairs of glabellar furrows has been described, and in that genus the palpebral lobes are longer, narrower, and much nearer the glabella than in *Clavaspidella*. The pygidium of *Clavaspidella* has more and narrower rings and ribs than does that of *Athabaskia*. These genera are unquestionably closely related, but they can be separated successfully.

[60] Chr. Poulsen: *The Cambrian, Ozarkian and Canadian faunas of Northwest Greenland*, Meddel. om Grönland, Bd. 70 (1927) p. 341.

[61] C. E. Resser: *Nomenclature of some Cambrian trilobites*, Smithsonian Inst., Mis. Coll., vol. 93 (1935) p. 20.

TRILOBITES OF THE LOWER PART OF THE GORGE FORMATION

One of the two largest faunules is that which Schuchert has found in the lowest fossiliferous zone of the Gorge formation. Previous explorations of this layer, which is only an inch or so in thickness, had revealed only seven species of trilobites. Schuchert's persistent labors have, howewer, been rewarded by the discovery of areas where fossils are relativly abundant, so that 37 named forms in 29 genera are now known from this bed. They are as follows:

Lowest zone (3) of the Gorge formation at Highgate Falls, Vermont:

Pseudosalteria laevis Raymond
Agnostus innocens Clark
Phalacroma parilis (Hall)
Phoreotropis puteata Raymond
Tostonia duplicata Raymond
T. unisulcata Raymond
Liostracinoides vermontanus Raymond
Chariocephalus peloris Raymond
Diatemnus miculus Raymond
Aposolenopleura dunbari Raymond
Protapatokephalus arctostriatus Raymond
P. spiculatus Raymond
P. granulatus Raymond
Apatokephaloides clivosus Raymond
A. inflatus Raymond
Acheilus macrops Raymond
Dikelocephalus insolitus Raymond
Richardsonella iole (Walcott)
Highgatea laeviuscula Raymond
H. bisinuata Raymond
Calvinella sp. ind.
Stenosaukia irrasa Raymond
Illaenurus breviceps Raymond
I. punctatus Raymond
Onchonotus nasutus (Walcott)
Lecanopyge expansa Raymond
Heterocaryon platystigma Raymond
Bathyurellus ? antiquus Raymond
Plethopeltis incisa Raymond
Plethometopus latus (Raymond)
Strotocephala howelli Raymond
Stenopilus pronus Raymond
Platydiamesus inornatus (Raymond)
P. depressus Raymond
P. subtilis Raymond
Lecanopleura inflecta Raymond
Punctularia ornata Raymond

Species common to this zone (1) and the upper zones (2 and 3):

Agnostus innocens Clark
Phalacroma parilis (Hall)
Phoreotropis puteata Raymond
Apatokephaloides clivosus Raymond
A. inflatus Raymond
Acheilus macrops Raymond
Stenopilus pronus Raymond
Plethometopus latus (Raymond)
Onchonotus nasutus (Walcott)
Illaenurus breviceps Raymond

Genera in this zone found in the Upper Cambrian elsewhere:

Tostonia
Liostracinoides
Chariocephalus
Calvinella
Illaenurus
Plethometopus
Plethopeltis

Genera in this zone of decidedly Cambrian affinities:

Aposolenopleura
Diatemnus
Stenosaukia
Highgatea

TRILOBITES OF THE HIGHER PART OF THE GORGE FORMATION

For the sake of completeness, a revised list of the trilobites of the upper zone of the Gorge formation is here added. There are now 41 named species in 27 genera, and, of the species, 10 survive from zone 1, and 11 genera are common to the two zones. The list is as follows:

Upper zone of the Gorge formation:

Agnostus innocens Clark
A. trisectus Salter
A. insuetus Raymond
Pseudagnostus extumidus Raymond
Peronopsis planulata Raymond
Phalacroma parilis (Hall)
P. cyclostigma Raymond
Stenopilus pronus Raymond
S. brevis Raymond
Hemirhodon juvenis (Raymond) = *Corynexochus juvenis* Raymond
Acheilus macrops Raymond
Idiomesus tantillus Raymond
Phoreotropis puteata Raymond
P. transversa Raymond
Zacompsus clarki Raymond
Onchonotus nasutus (Walcott)
Phylacterus saylesi Raymond
P. fraternus Raymond
Blountia imitator Raymond
Maryvillia triangularis Raymond
Lloydia seelyi (Walcott)
Plethometopus armatus (Billings)
P. latus (Raymond)
P. laevis (Raymond)
P. angustus (Raymond)
P. convergens (Raymond)
Apatokephaloides clivosus Raymond
A. inflatus Raymond
Protapatokephalus minutus (Raymond) = *Hungaia minuta* Raymond 1924
Saukia sp. ind. = *S. lodensis* (Whitfield) Raymond 1924
Saukiella inops Raymond = *Saukia stosei* (Walcott) Raymond 1924
S. dunbari Raymond = *Saukia dunbari* Raymond 1924
Richardsonella germana Raymond
Distazeris spicata (Raymond) = *Acheilus spicatus* Raymond 1924
Illaenurus quadratus Hall
I. breviceps Raymond
I. laevis Raymond
Platycolpus dubius (Billings)
Ptychaspis affinis Raymond
Keithia schucherti Raymond
Ambolium lioderma Raymond

It is obvious from the foregoing lists that the trilobite faunule in the lowest zone of the Gorge formation is rather closely related to that of the younger zones 2 and 3, which, in a previous paper, the writer grouped together as the "main zone." There are 10 species and 11 genera common to these zones. Although there are many species that have not so far been found in both zones, the two have enough species in common to indicate that no great amount of time had elapsed between the dates of the deposition of the younger and the older layers.

Because of the presence of *Plethometopus, Richardsonella,* and a few saukinids, the writer concluded, in his paper of 1924, that the strata of the "main zone" belonged to "the upper part of the Upper Cambrian," or about the same age as the Hoyt limestone (Saratogan) of eastern New York. The abundance of two species closely allied to *Apatokephalus* in the older zones, 80 feet below the "main zone," in the recently made collections, seemed at first to render this conclusion untenable. *Apatokephalus,* in Norway and Sweden, is characteristic of the upper layers of

the zone of *Ceratopyge*, a zone which Continental geologists consider as the oldest in the Ordovician. The writer has tried, in several papers, to show that the oldest strata of the American Ordovician have a fauna similar to that of the *Ceratopyge* zone of Europe; hence it was natural that the first impression should be that the Gorge formation was really oldest Ordovician rather than Upper Cambrian. This impression, however, was not sustained by further study. The inferred significance of the *Apatokephalus*-like trilobites was more than counterbalanced by the presence of such typically Upper Cambrian genera as *Tostonia, Liostracinoides, Chariocephalus, Saukia,* and *Illaenurus*—genera that are represented in the typical Upper Cambrian of the upper Mississippi Valley. The preponderance of evidence seems to indicate, therefore, that the *Apatokephalus* stock appeared in North America earlier than it did in northern Europe. This is in agreement with a suggestion put forward by the writer some years ago—namely, that, in general, benthonic animals appeared in Eurasia about one period earlier or later than they did in North America.

FAUNAS OF THE HIGHGATE AND GRANDGE FORMATIONS

In the section at Highgate Falls, the Gorge formation is overlain by the Highgate, the lower part of which consists of thin layers of limestone interbedded with calcareous shale, grading upward into the banded shales so characteristic of the upper part of the formation. At most localities, shearing has produced a secondary cleavage, which renders collecting difficult. One of the best places at which to obtain the fossils of this formation is in a pasture north of the road at Highgate Falls, just northwest of the head of the gorge, which is the typical locality for the Gorge formation. The fossils found there and at nearby localities are obviously those that pertain to the lower part of the Highgate. This trilobite faunule, as represented in collections made by Schuchert and the writer, is as follows:

Agnostus sp. ind.
Hypagnostus sp. ind.
Leptopilus declivis Raymond
Cholopilus vermontanus Raymond
Leiostegium puteatum Raymond
L. cingulosum Raymond
Maryvillia triangularis Raymond
Lloydia seelyi (Walcott)
L. saffordi (Billings)
Hemigyraspis sp. ind.
Metapliomerops extenuatus (Raymond)
Pilekia apollo (Billings)

Regarding these twelve species of trilobites, the writer said in his paper of 1924 that only two are known in older strata—namely, *Maryvillia triangularis* and *Lloydia seelyi.* On the other hand, the most common species, *Leiostegium puteatum* and *Metapliomerops extenuatus,* belong to genera that are characteristic of the Lower Ordovician, as is *Hemigyraspis.* The specimens of *Lloydia saffordi* are large and closely comparable to

those found in the Beekmantown at Philipsburg, Quebec, and *Cholopilus vermontanus* as well as *Lloydia saffordi* are found in the next higher formation, the Grandge. *Pilekia* and *Hemigyraspis* are the only genera that belong to the *Ceratopyge* fauna.

This evidence seems to indicate that the Highgate formation is of Ordovician, rather than of Cambrian, age, but should be placed about on the border between the two.

It is difficult to trace formations in northwestern Vermont, but Keith was able to follow the Highgate northward 4.5 miles (N10°E) to the Grandge farm, half a mile south of the International Boundary. At this locality, there is exposed a structure which Keith and all geologists who have since seen it have interpreted as an angular unconformity between the Highgate and the overlying Grandge shales.

In the layers immediately above this structure, in the Grandge formation, fossils are relatively common, and the following brachiopods and trilobites have been identified by G. Arthur Cooper and the writer:

Orthidium cf. *O. gemmicula*
Syntrophina sp. ind.
Archaeorthis sp. ind.
Clarkella sp. ind.
Cholopilus vermontanus Raymond
Petigurus cybele (Billings)
Gignopeltis rara (Billings)
Hystricurus mammatus Raymond
Pilekia eryx (Billings)
Lloydia saffordi (Billings)
Leiostegium obtectum (Raymond)

Three of these species are found in the lower Highgate—*Cholopilus vermontanus, Leiostegium obtectum,* and *Lloydia saffordi*—and the two faunas are in many ways similar. Present knowledge of the Lower Ordovician does not permit a positive correlation, but the writer's impression is that the Grandge is of early Beekmantown age.

Until 1928, no fossils had been found below the "unconformity", but in the fall of that year the writer had the opportunity to revisit the locality, and with McGerrigle, was fortunate enough to find a fairly productive layer about 15 feet below the discordant parting. Since that time, Schuchert and Clark and F. B Phleger and the writer have made collections from several layers within 15 feet below the contact. A study of the specimens has resulted in the following identifications:

Lecanospira sp. ind.
Dirachopia sp. ind.
Shumardia granulosa Billings
Entomaspis clarki Raymond
Triarthroides cyclas Raymond
Diplozyga striata Raymond
Warburgella plana Raymond
W. angelini (Billings)
Perischodory grandgei Raymond
Lloydia saffordi (Billings)
L. brevis Raymond
Leiostegium elongatum Raymond
L. obtectum (Raymond)
Diplapatokephalus multispinosus Raymond
Metoptogyrus grandgei Raymond
Metapliomerops latidorsatus Raymond
Strototropis laeviuscula Raymond
S. elevata Raymond
Leiostrototropis phlegeri Raymond

L. laevis Raymond
Isochilina puteata Raymond
I. tenuifilum Raymond
I. eximia Raymond
I. bilabiata Raymond
Plumulites mobergi Clark

Species found above, in the basal Grandge formation, are:

Lloydia saffordi (Billings)
Leiostegium obtectum (Raymond)

Species known from the Shumardia limestone of the Lévis formation at Lévis, are:

Warburgella angelini (Billings)
Shumardia granulosa Billings
Plumulites mobergi Clark

Genera of Ordovician affinities, are:

Triarthroides
Shumardia
Warburgella
Metoptogyrus
Metapliomerops
Leiostrotropis
Strototropis
Plumulites
Isochilina

Genera of Ordovician and Upper Cambrian range, are:

Entomaspis
Lloydia

A surprising and significant feature of this list of species is the presence of three forms which were previously known in the Shumardia limestone at Lévis. As it is in this zone at Lévis that the first of the diplograptid graptolites appear, it has been generally considered to be high in the Beekmantown, if not the oldest of the Mid-Ordovician series. The presence of ostracods is additional evidence that this is an Ordovician, rather than a Cambrian, fauna.

Significant also are the Cheiruridae, all of which belong to the group with small free cheeks and the eyes far forward. This group is characteristic of the oldest Ordovician deposits in Scandinavia and Manchuria.

As the fossils, both above and below the structural discordance, are Lower Ordovician, it seems that the "break" itself is of no great significance.

TRILOBITES OF THE ROCKLEDGE CONGLOMERATE

General Statement.—An important problem, on which the fossils have thrown considerable light, is that of the age of the conglomerate so conspicuous in a discontinuous belt from south of Georgia Center to the neighborhood of Hungerford Brook, a mile south of Highgate Falls. It overlies the Hungerford shale, which, in turn, rests upon the Mid-Cambrian St. Albans formation.

One of the best localities for the study of the conglomerate is a large outcrop west of the road, 3.5 miles north of St. Albans and one mile south

of Rockledge. Here the matrix is extremely sandy, in places made up almost entirely of wind-blown quartz grains, with only enough calcareous cement to hold them together. At or near the base are definite layers of the matrix, partly a calcareous sandstone and partly a sandy dolomite. From material of the latter sort, Schuchert obtained the following trilobites:

Hysteropleura macgerriglei Raymond
Paracrepicephalus cf. *P. thoosa* (Walcott)
Idahoia minor Raymond
Dunderbergia vermontensis Raymond
Ucebia simplex Raymond
U. lata Raymond
Illaenurus breviceps Raymond
I. sp. ind.
Coleopachys pisum Raymond
Cephalocoelia ovoides Raymond

An analysis of this fauna shows:
Species found also in the Gorge formation:

Illaenurus breviceps Raymond

Species found also in the pebbles of a loose block of Rockledge conglomerate near the limestone lentil in the Hungerford shale northwest of Georgia Center:

Ucebia lata Raymond, *Hysteropleura macgerriglei* Raymond.

Species found also in the pebbles of the Rockledge conglomerate at Rockledge:

Illaenurus breviceps Raymond

Genera found elsewhere in the Upper Cambrian:

Hysteropleura,
Paracrepicephalus,
Idahoia,
Dunderbergia,
Ucebia,
Illaenurus.

In a layer of sand with a calcareous cement near the top of the conglomerate, the writer recently found:

Coleopachys strix Raymond, *Ucebia lata* Raymond.

These fossils are important, for there had hitherto been some question as to whether the basal layers were really Rockledge or whether they represented remnants of an older formation upon whose eroded surface the Rockledge was deposited. There was even a suspicion that the basal layers might be part of a large, flat boulder. The presence of *Ucebia lata* in both faunas demonstrates that the basal layers are a part of the Rockledge itself. The presence of the same species and of *Hysteropleura macgerriglei* in the boulders in the conglomerate northwest of Georgia Center, and of *Coleopachys strix* in a pebble at Rockledge, indicates that

some, at least, of the pebbles are penecontemporaneous with the matrix. This suggests that the conglomerate is of reef origin, its materials subject to occasional emergences, partial consolidation, and destructive wave action, a view already held by Keith.

The presence of *Paracrepicephalus, Idahoia, Dunderbergia,* and *Illaenurus* in the matrix fixes the age of the Rockledge definitely as Upper Cambrian. If present ideas as to the vertical distribution of *Paracrepicephalus* are correct, it is a rather early Upper Cambrian fauna, contemporaneous with that of the upper part of the Eau Claire formation of the upper Mississippi Valley.

Fossils from Boulders Northwest of Georgia Center.—A loose boulder of conglomerate undoubtedly derived from the Rockledge was found near the fossiliferous lentil in the Hungerford slate northwest of Georgia Center. The pebbles in this boulder contained the following trilobites:

Hysteropleura macgerriglei Raymond,
Onchonotus eminens Raymond,
Ucebia lata Raymond,
Distazeris acuta Raymond,
Calvinella obsoleta Raymond,
Illaenurus breviceps Raymond,
Tsinania scrinium Raymond,
Stenocombus princeps Raymond,
Hemirhodon minor Raymond,
H. schucherti Raymond,
Lecanopleura interrupta Raymond,
L. inflecta Raymond.

Of the above, the following are found also in the Gorge formation:

Illaenurus breviceps Raymond
Lecanopleura inflecta Raymond

Genera represented also in the Gorge formation:

Illaenurus,
Lecanopleura,
Calvinella,
Onchonotus.

Genera known elsewhere in the Upper Cambrian:

Tsinania,
Ucebia,
Illaenurus,
Calvinella,
Hysteropleura.

Genera of distinctly Cambrian affinities:

Hemirhodon.

Species found also in the matrix of the conglomerate a mile south of Rockledge:

Illaenurus breviceps Raymond,
Hysteropleura macgerriglei Raymond.

Fossils from Pebbles at Rockledge.—At, or near, Rockledge, which is 4.5 miles north of St. Albans, several fossiliferous pebbles have been found in the conglomerate.

The following list combines the trilobites of two pebbles (numbered 1 and 2):

Agnostus innocens Clark, 1,
Ucebia lata Raymond, 1, 2,
Protillaenus marginatus Raymond, 1,
Illaenurus breviceps Raymond, 2,
Stenopilus pronus Raymond, 2,
Kaninia? platys Raymond, 2,
Bynumia leptogaster Raymond, 2,
Greylockia minuta Raymond, 2,
Maryvillia triangularis Raymond, 2,
Homodictya imitatrix Raymond, 2,
Coleopachys strix Raymond, 2,
Stenelymus kobayashii Raymond, 2,
Hemirhodon schucherti Raymond, 2,
Acrohybus argutus Raymond, 2.

Species found also in the Gorge formation:

Agnostus innocens Clark,
Illaenurus breviceps Raymond,
Stenopilus pronus Raymond,
Maryvillia triangularis Raymond.

Species found also in the matrix of the conglomerate, one mile south of Rockledge:

Illaenurus breviceps Raymond,
Ucebia lata Raymond.

Species found also in the limestone lentil of the Hungerford slate northwest of Georgia Center:

Hemirhodon schucherti Raymond.

Species found also in the loose block from the Rockledge conglomerate northwest of Georgia Center, Vermont:

Ucebia lata Raymond,
Illaenurus breviceps Raymond.

Genera common to this last-mentioned block and the matrix of the Rockledge a mile south of Rockledge:

Illaenurus,
Coleopachys.

Genera known from the Upper Cambrian elsewhere:

Ucebia,
Illaenurus,
Bynumia,
Maryvillia,
Stenelymus.

The writer was first introduced to the problem of the age of the Rockledge conglomerate and the ages of the limestone pebbles in it during a visit to the region with Schuchert in 1921. At that time, only a few fossils were found in the pebbles. All were small trilobites, which seemed very similar to those collected in the Gorge formation at Highgate Falls. Therefore it seemed logical to believe that the Rockledge was younger than the Gorge.

Detailed study has, however, led the writer to the conclusion that the conglomerate is probably older than the Gorge, and that it represents a part of a shallow-water reef deposit, which may have furnished calcium

carbonate to that formation. In other words, the Potsdam represents the strand and near-shore facies of the Upper Cambrian deposits, the conglomerate an accumulation upon off-shore bars and islands some distance east of the coast, and the Gorge a still more easterly deposit whose material was derived through the destruction of the reefs. This is, of course, merely a hypothesis put forward for the consideration of future workers in the area.

The reasons for this opinion are:

(1) The general similarity of the fauna of the conglomerate to that of the Gorge. Although there are only five species—*Agnostus innocens, Illaenurus breviceps, Lecanopleura inflecta, Stenopilus pronus,* and *Maryvillia triangularis*—common to the two, the genera *Onchonotus, Hemirhodon,* and *Calvinella* are represented in both. One would expect considerable differences in fauna if one deposit were formed on a reef, another under quiet conditions.

(2) The extraordinary amount of sand in the matrix of the conglomerate, and in the pebbles derived from that matrix, indicates some connection with the Potsdam sandstone. Solution of a piece of the matrix yielded quartz sand, with only a trace of other insoluble residue. All the grains are more or less rounded, some nearly spherical. The largest grains, according to Henry C. Stetson, who made the analysis, are 1.61 millimeters in diameter. They compose only 0.09 per cent of the sample. The smallest present in any appreciable amount (2.1 per cent of the sample) are about 0.104 millimeter in diameter. A few grains, however, passed through the sieve of 0.074 millimeter mesh. The median is 0.48 millimeter. The sorting is good, and the characteristics are those of a wind-borne sand. At first sight, the grains appear to be frosted, but upon examination under the microscope, this appearance is seen to be due to minute irregularities, which Harry Berman believes are due to solution. Solution in dilute hydrochloric acid freed most of the grains of sand from one another, but there are a few aggregates, held together by a siliceous cement. This suggests that the sand may have been subjected to some solution and cementation in place.

The writer finds no recent studies on the petrology of the sands of the Potsdam of northeastern New York. Van Ingen [62] stated that the lower part of the Potsdam consists of coarse, ill-sorted sand containing feldspar and magnetite. In the middle the sorting is better, the grains are smaller, some rounded, but dominantly angular; feldspar is rare or absent. "In the upper levels frequent beds are composed of nicely rounded grains of clear quartz with little cement, that crumble to a sugary powder under the hammer." Interbedded with such strata are layers of dolomite. As is

[62] Gilbert Van Ingen: *The Potsdam sandstone of the Lake Champlain basin; notes on field work, 1901,* N. Y. State Mus., Bull. 52 (1902) p. 543.

well known, the Potsdam at several localities grades upward into the Beekmantown without any pronounced lithologic change, the beds becoming gradually more calcareous. Whether the inference, based upon lithology, that the Rockledge is of about the same age as the upper part of the Potsdam has any value, future investigations alone can tell.

(3) As shown in Schuchert's report on this region, the Hungerford shale contains many lenticular masses of limestone, which are interpreted as bioherms. It is very probable that the Rockledge is a series of such bioherms, all formed at one time. The action of the waves would tend to concentrate the rather coarse wind-blown sand in the shallows in which these reef-like masses were growing. Such action would take place both west and east of the reef, and so tend to prevent the sand from reaching the quieter waters in which the Gorge limestone was deposited.

The age of the Rockledge can probably be determined rather accurately as soon as the studies now being carried on in the upper Mississippi Valley are completed. The writer has had to depend upon the totally inadequate information now available in print. According to Christina Lochman,[63] the Rockledge contains elements of the *Cedaria* fauna, one of the oldest of the Upper Cambrian. The most important contribution of the present paper is to show that the faunas of pebbles and matrix are of the same age.

FOSSILS OF THE CORLISS CONGLOMERATE

The only fossils which the writer has seen from the true Corliss conglomerate at Corliss Ledge are those of three pebbles collected by Schuchert and the writer in 1921. Nothing has so far been found in the matrix. These fossils are fairly well preserved, for this area, but, unfortunately, all but a few are so fragmentary as to be useless. The general aspect of the fauna is distinctly Ordovician, for most of the fragments can be identified as remnants of asaphid trilobites. The brief list of species is as follows:

Symphysurina globosa Raymond
S. parva Raymond
Symphysurinella corlissensis Raymond
Symphysuroides latus Raymond

Symphysurina, as restricted to trilobites with well-defined pygidial axial lobe and terminal spine, is known only from the oldest Ordovician strata, including the Oneota dolomite of Wisconsin, the Goodwin formation of the Eureka district, Nevada, and the Mons formation of western Alberta. *Symphysurinella* has been found elsewhere only in the Mons of Alberta. *Symphysuroides*, as the name indicates, is very like the north-European *Symphysurus*, but probably represents a parallel evolution, for it appears to belong to the Asaphidae rather than the Symphysuridae. All the evidence to be derived from the trilobites indicates that the

[63] Christina Lochman: personal communication.

pebbles in the Corliss are of lowest Ordovician age. The conglomerate may be a bioherm of the same age as the older part of the Highgate.

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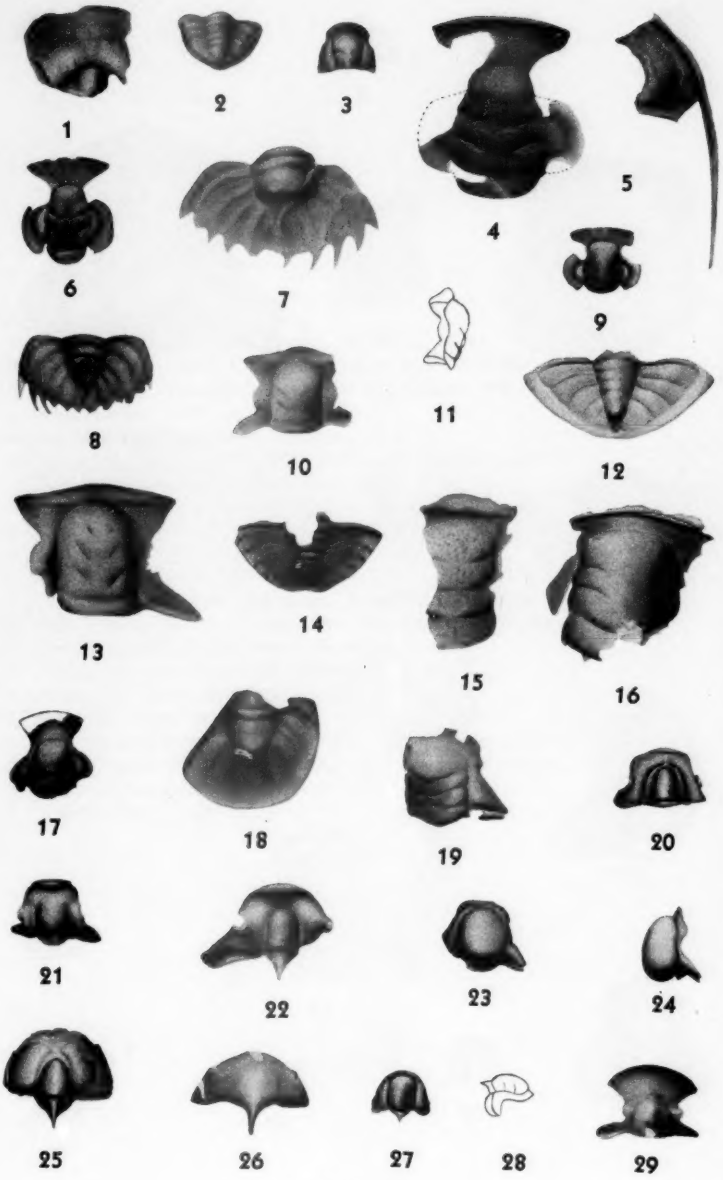
Explanation of Plates

PLATE 1

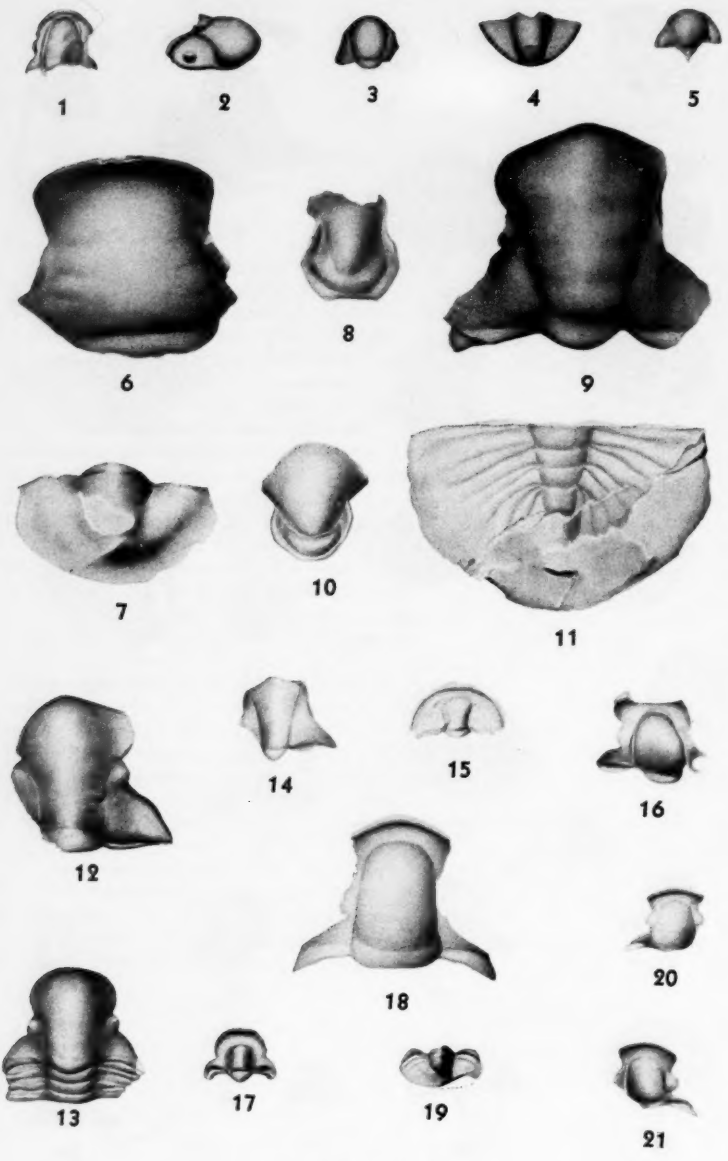
TRILOBITA

Fig.

1. *Entomaspis clarki* Raymond. Holotype, × 2.
2. *Diplozyga striata* Raymond. Holotype, × 4.
3. *Triarthroides cyclas* Raymond. Holotype, × 6.
4. *Protapatokephalus arctostriatus* Raymond. Holotype, × 4.
5. Same species. Paratype (free cheek), × 4.
6. Same species. Paratype (cranidium), × 4.
7. Same species. Paratype (pygidium), × 4.
8. *Protapatokephalus spiculatus* Raymond. Holotype (pygidium), × 4.
9. *Protapatokephalus granulatus* Raymond. Holotype (cranidium), × 4.
10. *Highgatea laeviuscula* Raymond. Holotype (cranidium), × 2.
11. Same species. Profile of cranidium, × 2.
12. Same species. Paratype (pygidium), × 2.
13. *Highgatea bisinuata* Raymond. Holotype (cranidium), × 2.
14. Same species. Paratype (pygidium), × 2.
15. *Saukia* sp. ind. Imperfect cranidium, × 2.
16. *Saukiella inops* Raymond. Holotype, × 2.
17. *Stenosaukia irrasa* Raymond. Holotype, × 4.
18. *Calvinella obsoleta* Raymond. Holotype, × 2.
19. *Diatemnus miculus* Raymond. Holotype, × 4.
20. *Liostracinoides vermontanus* Raymond. Holotype, × 4.
21. *Aposolenopleura dunbari* Raymond. Holotype, × 4.
22. *Hysteropleura macgerriglei* Raymond. Holotype, × 4.
23. *Onchonotus eminens* Raymond. Holotype, dorsal view, × 4.
24. Same species. Holotype, lateral view, × 4.
25. *Clelandia parabola* (Cleland). A specimen from the Tribes Hill formation at Canajoharie, New York. Figured to show the large nuchal spine, which has previously been overlooked. × 4. Cat. No. 3841, M. C. Z.
26. *Strotocephala howelli* Raymond. Holotype, × 4.
27. *Distazeris acuta* Raymond. Holotype, dorsal view, × 4.
28. Same species. Holotype, outline profile, × 4.
29. *Acrohybus argutus* Raymond. Holotype, × 4.



TRILOBITA
Anne Lewis Lalicker, del.



TRILOBITA
Anne Lewis Lalicker, del.

PLATE 2

TRILOBITA

Fig.

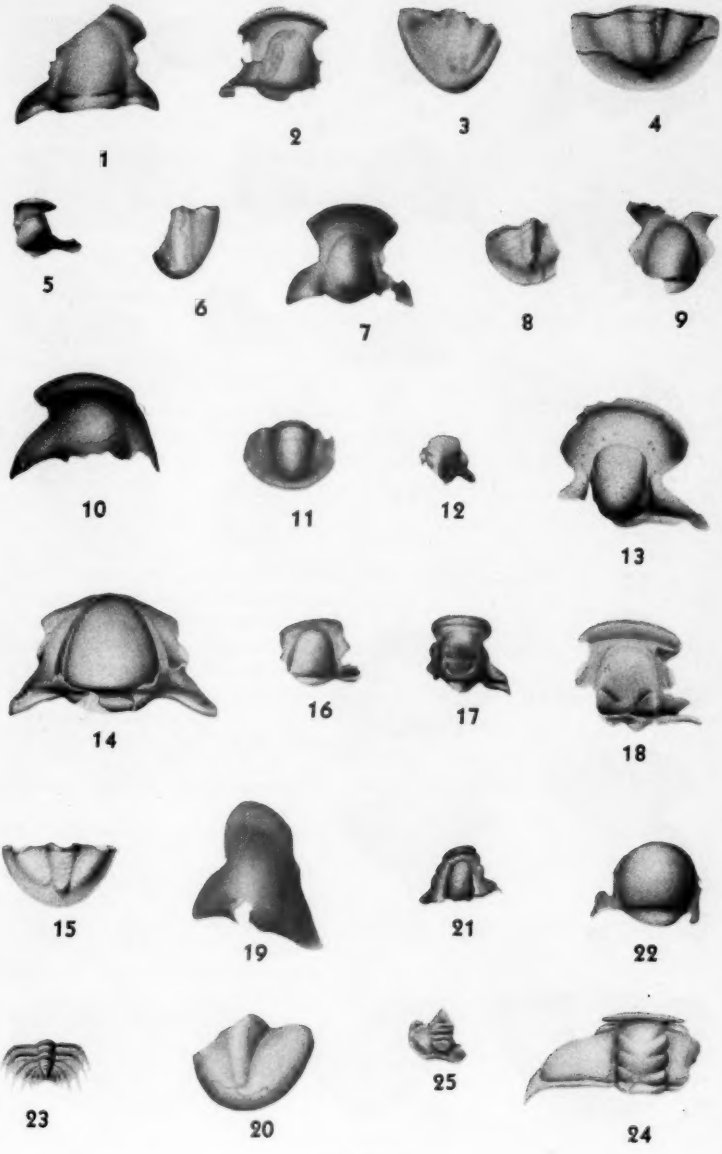
1. *Stenelymus kobayashii* Raymond. Holotype, × 2.
2. *Ucebia lata* Raymond. Holotype, lateral view of cephalon, × 2.
3. Same species. Paratype, dorsal view of cephalon, × 4.
4. Same species. Paratype (pygidium), × 4.
5. *Ucebia simplex* Raymond. Holotype, × 4.
6. *Lecanopyge expansa* Raymond. Holotype (cranidium), × 2.
7. Same species. Paratype (pygidium), × 2.
8. Same species. Paratype (hypostoma), × 2.
9. *Hemirhodon viator* Raymond. Holotype, × 2.
10. Same species. Paratype (hypostoma), × 2.
11. Same species. Paratype (pygidium), × 2.
12. *Hemirhodon schucherti* Raymond. Paratype (cranidium), × 2.
13. Same species. Holotype (cranidium and three thoracic segments), × 2.
14. *Hemirhodon minor* Raymond. Holotype, × 4.
15. *Warburgella plana* Raymond. Holotype, × 2.
16. *Greylockia minuta* Raymond. Holotype, × 4.
17. *Stenocombus princeps* Raymond. Holotype, × 4.
18. *Platydiamesus inornatus* (Raymond). Plesiotype (cranidium), × 4.
19. Same species? Pygidium referred with doubt to this species, × 4.
20. *Platydiamesus depressus* Raymond. Holotype, × 2.
21. *Platydiamesus subtilis* Raymond. Holotype, × 4.

PLATE 3

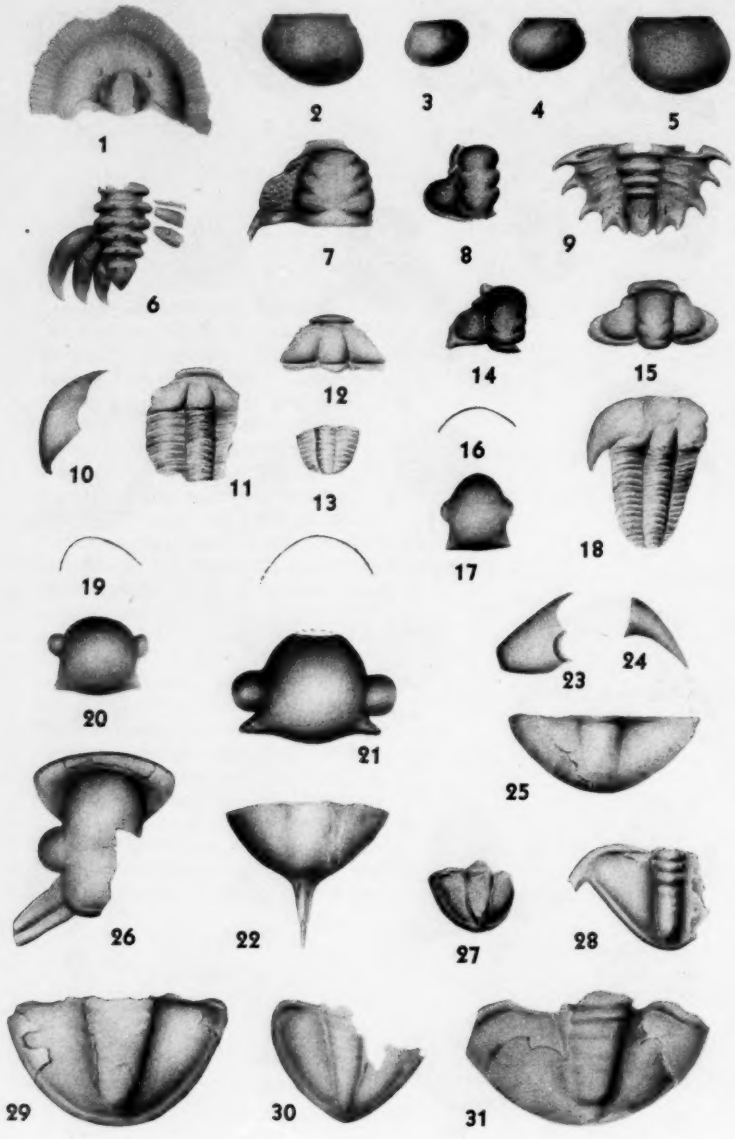
TRILOBITA

Fig.

1. *Lecanopleura interrupta* Raymond. Holotype, × 2.
2. *Lecanopleura inflecta* Raymond. Holotype, × 4.
3. *Maryvillia triangularis* Raymond. Plesiotype, × 4.
4. *Kaninia ? platys* Raymond. Holotype, × 2.
5. *Idahoia minor* Raymond. Holotype, × 2.
6. *Tsinania scrinium* Raymond. Holotype, × 2.
7. *Homodictya imitatrix* Raymond. Holotype (cranidium), × 4.
8. Same species. Paratype (pygidium), × 2.
9. *Dunderbergia vermontensis* Raymond. Holotype, from which much of the rim and brim have been removed, × 4.
10. *Protillaenus marginatus* Raymond. Holotype, × 2.
11. *Bathyurellus ? antiquus* Raymond. Holotype, × 2.
12. *Chariocephalus peloris* Raymond. Holotype, × 4.
13. *Heterocaryon platystigma* Raymond. Holotype, × 4.
14. *Coleopachys strix* Raymond. Holotype, × 2.
15. Same species. Paratype (pygidium), × 2.
16. *Coleopachys pisum* Raymond. Holotype, × 4.
17. *Tostonia duplicata* Raymond. Holotype, × 2.
18. *Tostonia unisulcata* Raymond. Holotype, × 4.
19. *Bynumia leptogaster* Raymond. Holotype (cranidium), × 4.
20. Same species. Paratype (pygidium), × 2.
21. *Punctularia ornata* Raymond. Holotype, × 4.
22. *Cephalocoelia ovoides* Raymond. Cranidium, × 6.
23. *Diplapatokephalus multispinosus* Raymond. Holotype, × 2.
24. *Strototropis laeviuscula* Raymond. Holotype, × 1⅓.
25. *Paracrepicephalus* cf. *P. thoosa* Walcott. Imperfect pygidium, × 2.



TRILOBITA
Anne Lewis Lalicker, del.



TRILOBITA AND OSTRACODA
Anne Lewis Lalicker and Susanne Okulitch, del.

PLATE 4

TRILOBITA AND OSTRACODA

Fig.

1. *Entomaspis clarki* Raymond. Paratype, × 2.
2. *Isochilina tenuifilum* Raymond. × 4.
3. *Isochilina eximia* Raymond. × 4.
4. *Isochilina bilabiata* Raymond. × 4.
5. *Isochilina puteata* Raymond. × 4.
6. Pygidium of a cheirurid, possibly that of *Strototropis laeviuscula*. × 2. No. 4450, M. C. Z.
7. *Pilekia apollo* (Billings). × 2.
8. *Strototropis elevata* Raymond. × 2.
9. *Metapliomerops latidorsatus* Raymond. × 2.
10. *Antagmus schucherti* Raymond. A free cheek. × 4.
11. The same species. A somewhat distorted cranidium and part of thorax. × 2.
12. The same species. A cranidium, the holotype. × 2.
13. The same species. A pygidium. × 2.
14. *Leiostrototropis phlegeri* Raymond. × 2.
15. *Leiostrototropis laevis* Raymond. × 2.
16. *Symphysurina parva* Raymond. Longitudinal profile. × 2.2.
17. The same species. A cranidium. × 2.2.
18. *Apedopyanus parkeri* Raymond. × 2.
19. *Symphysurina globosa* Raymond. Longitudinal profile. × 2.
20. The same species. A cranidium. × 2.
21. *Symphysurinella corlissensis* Raymond. A cranidium, the paratype, with profile of same above it. × 2.
22. The same species. A pygidium, the holotype. × 2.
23. *Symphysuroides latus* Raymond. A free cheek. × 2.
24. The same species. Doublure of a free cheek, showing lack of epistomal suture. × 2.
25. The same species. A pygidium, the holotype. × 2.
26. *Metoptogyrus grandgei* Raymond. The holotype. × 2.
27. *Lloydia brevis* Raymond. × 2.
28. *Perischodory grandgei* Raymond. × 2.
29. *Leiostegium obtectum* Raymond. A plesiotype. × 2.
30. *Leiostegium elongatum* Raymond. × 2.
31. *Cholopilus magnus* Raymond. × 2.

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CAMBRIAN *CENTROPLEURA VERMONTENSIS* FAUNA OF NORTHWESTERN VERMONT

BY B. F. HOWELL

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INTRODUCTION

HISTORY OF PREVIOUS WORK

So many remarkable fossils have been found in the Cambrian rocks of northwestern Vermont that Franklin County has become classic ground for students of Early Paleozoic life. Some of the first well-preserved Early Cambrian fossils ever discovered were collected in that region; and now one of the most surprising Middle Cambrian faunas ever unearthed in North America has been recovered from the St. Albans Shale, in the vicinity of St. Albans.

This unexpected new fauna, which has been named from one of its most characteristic fossils, the *Centropleura vermontensis* fauna, contains 1

species of echinoderm, 8 species of brachiopods, 3 species of snails, 4 species of pteropods, no less than 47 species of trilobites, and one species of chordate—the oldest chordate yet discovered. It is the only fauna of its kind known in North America; and the only faunas comparable with it that have been described occur in rocks which crop out thousands of miles away in Scandinavia, and on Bennett Island north of Siberia.

This St. Albans Shale fauna is described in the present paper. All its 64 species appear to be unknown outside of Vermont. A few of them have been described in recent years; redescriptions of them, and descriptions of the remaining 61, are given below.

Although scientists have been searching for fossils in the Cambrian rocks of northwestern Vermont for the past hundred years, the rocks have very grudgingly yielded up their paleontological treasures; and it has only been within the last forty-five years that enough has been known about their fossils to build up in one's imagination a picture of the life that flourished in the arm of the Atlantic Ocean whose waters covered that region at various times in the Cambrian Period. In 1887 and 1891, C. D. Walcott[1] described the fossils which he found in the shales and limestones that had been deposited in Early Cambrian times, and a few years ago, P. E. Raymond[2] published an account of a collection of Late Cambrian fossils from Highgate Falls. Descriptions of individual species have also appeared from time to time since 1847. The *Centropleura vermontensis* fauna, which is the subject of this paper, was the first one of Middle Cambrian, or Paradoxidian, age to be discovered in Vermont, and is, for several reasons, of peculiar interest to students of Cambrian paleontology.

The most characteristic types of fossils in the Paradoxidian faunas are large trilobites belonging to the genus *Paradoxides*, and paleontologists have consequently gotten into the habit of calling these faunas *Paradoxides* faunas. Although older faunas have now been discovered, the *Paradoxides* faunas still hold a prominent place in the minds of paleontologists, for they remain the best known of all the Cambrian faunas of Europe; and, having been the first Middle Cambrian ones to be studied and described, they are the standard faunas of that age for the entire world.

As a standard for world-wide use, however, they have not been entirely satisfactory, because they have been definitely known to occur only in

[1] C. D. Walcott: *Second contribution to the studies on the Cambrian faunas of North America*, U. S. Geol. Surv., Bull. 30 (1887). (Dated 1886, issued in 1887.) C. D. Walcott: *The fauna of the Lower Cambrian or Olenellus zone*, U. S. Geol. Surv., 10th Ann. Rept., pt. 1 (1890) p. 509-774. (Dated 1890, issued in 1891.)

[2] P. E. Raymond: *New Upper Cambrian and Lower Ordovician trilobites from Vermont*, Boston Soc. Nat. Hist., Pr., vol. 37, no. 4 (1924) p. 389-466, pl. 12-14; reprinted in 14th Biennial Rept. Vermont State Geologist, 1923-1924 (1924) p. 137-203, pl. 12-14.

regions around the North Atlantic Ocean. The faunas which are thought to be of the same age elsewhere contain no *Paradoxides* and only a few other animals that are similar enough to species in the *Paradoxides* faunas to make close time correlations possible. This has been a great handicap to students of Cambrian paleontology and stratigraphy, and has led them to try to widen the area in which these faunas were known to be present. It was especially desired to find such faunas farther east in Eurasia and farther west in North America, so that correlations could be made between the *Paradoxides* beds of the North Atlantic region and the Cambrian strata believed to be of Paradoxidian age in Asia, Australia, and western North America.

The three areas in which *Paradoxides* faunas had been found in the Western Hemisphere—southeastern Newfoundland, southeastern New Brunswick, and eastern Massachusetts—were all in the narrow belt of Cambrian rocks (the Acadian geosyncline) that extends, now intermittently, along the northeastern coast of North America. The main belt of Cambrian rocks of the eastern part of the continent lay farther to the west, along the eastern edge of the Appalachian Mountains (the St. Lawrence geosyncline). It was separated from the belt in which the *Paradoxides* faunas had been found by a wide band of pre-Cambrian rocks (New Brunswick geanticline). No good faunas of undoubted Paradoxidian age had been discovered in this Appalachian, western Cambrian belt, but the early Cambrian and late Cambrian ones found there were thought by the paleontologists to be more closely related to those of the part of the continent west of the Appalachians than to the Early and Late Cambrian faunas found in the North Atlantic Basin.

Northwestern Vermont was considered to lie in the Appalachian belt, and its Cambrian faunas were thought to belong in what was called the "Western," or "Pacific," life province, as distinguished from the "Eastern," or "Atlantic," province. No traces of a *Paradoxides* fauna had been found in Vermont, although the Cambrian rocks of the State had been much studied, and many Early Cambrian, and a few Late Cambrian, fossils had been found in them. No fossils which looked as though they were of Middle Cambrian age had been found there; but it was thought that if any were discovered (which did not seem likely to happen) they would prove to belong to a fauna of "Western" type. Thus, it came as a great surprise to American paleontologists and geologists, when, in 1908, G. H. Perkins, the State Geologist of Vermont, announced that C. D. Walcott had found trilobites, which he identified as members of a *Paradoxides* fauna, in collections of fossils that had been gathered in Franklin County by himself and by a local amateur geologist, G. E. Edson.[3]

[3] G. H. Perkins: *Preliminary report on the geology of Franklin County*, Rept. State Geologist on the Mineral Industries and Geology of Certain Areas of Vermont, for 1907 and 1908 (1908) p. 208, 209.

In describing the limestone conglomerates and associated shales of St. Albans and vicinity, Edson[4] had recorded the finding "in shale in the intraformational conglomerate on the west side of St. Albans" of a brachiopod, which he identified as *Lingulepis acuminata* (an Upper Cambrian species), but which is described in the present paper as *Lingulella* (*Lingulepis*) *vermontensis;* and stated that he had found the same brachiopod and a trilobite, of the genus *Agnostus,* in blocks in the glacial drift in the same vicinity. The trilobite is now in the paleontological collection of Princeton University, and is here described as the holotype of *Hastagnostus angustus.*

The shale from which most of these fossils came—some of them came from the overlying Mill River Conglomerate—is the St. Albans Shale, of Paradoxidian Cambrian age, from which all but a few of the fossils described in the present paper were collected (a few of the specimens here described came from St. Albans pebbles in the Mill River Conglomerate). This shale occurs beneath, and not interbedded with, the "intraformational conglomerate," which is now known as the Mill River formation.

In his great monograph on the Cambrian brachiopods, published in 1912, Walcott recorded a number of fossils from beds in Franklin County, which he believed to be more or less certainly of Paradoxidian age. He stated that three species—the brachiopods, *Obolus matinalis* and *Huenella vermontana,* and a trilobite, *"Paradoxides sp."*—had been found in Middle Cambrian beds of the St. Albans formation at St. Albans, the *Huenella* and the *"Paradoxides"* occurring in association in an intraformational conglomerate; and that three other species—the brachiopods, *Lingulella franklinensis* and *Huenella billingsi,* and a trilobite, *Ptychoparia adamsi*—had been collected from a "limestone lentile" about a mile east of Parker's Quarry, in Georgia Township, which he referred with some doubt to the Middle Cambrian.[5]

Of these specimens, those referred to *Obolus matinalis* were only doubtfully identified as belonging to that species. Examination of the specimens on which this record was based shows that they came from the true Paradoxidian St. Albans formation, whose fauna is described in the present paper, and that they are examples of the species here described as *Lingulella* (*Lingulepis*) *vermontensis.*

The *Huenella vermontana* is believed to have come from the Upper Cambrian Mill River formation, on the evidence of the nature of the rock in which the type specimen is preserved and the locality where it was found.

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[4] G. E. Edson: *The geology of St. Albans and vicinity,* Rept. State Geologist on the Mineral Industries and Geology of Certain Areas of Vermont, for 1905 and 1906 (1906) p. 143.

[5] C. D. Walcott: *Cambrian Brachiopoda,* U. S. Geol. Surv., Mon. 51 (1912) p. 100, 102, 109, 115, 116, 119, 159, 189, 251, 402, 501, 502, 806, 809, text fig. 76, pl. 26, fig. 3, 3a, 3b; pl. 102, fig. 5, 5a-c.

The beds from which the specimens on which the species, *Huenella billingsi,* was founded are now known to be, not of Paradoxidian, but of Late Cambrian, age.

The specimens on which the species, *Lingulella franklinensis,* was based also came, not from Paradoxidian beds, but from Upper Cambrian strata.

The *"Paradoxides"* has now been proved, by the finding of better preserved specimens than any which Walcott had, to belong, not in the genus *Paradoxides,* but in the closely related genus of the same family, *Centropleura,* and is the species which is described in the present paper as *Centropleura vermontensis,* the species which gives its name to the fauna with which the paper deals.

The specimens which Walcott identified as *Ptychoparia adamsi* are not that species, but another, unnamed one. They come from Upper Cambrian strata, whereas the true *Ptychoparia adamsi* is known to occur only in Lower Cambrian rocks.

Walcott did not in his 1912 monograph mention an *Hyolithes,* a *Leperditia,* two species of *Agnostus,* an *Agraulos,* or an *Anomocare,* which he had included in the list submitted by him to Perkins in 1908, and he listed only one species of *Ptychoparia* from the Middle Cambrian of Vermont. The writer has probably seen all the specimens from the Middle Cambrian of Vermont which were examined by Walcott. Among them, he has found species of *Hyolithes, Agnostus, Agraulos,* and *Anomocare,* and other specimens which Walcott might have assigned to *Ptychoparia;* but he has not seen any which looked like *Leperditia* or *Menocephalus.*

In 1922 the author undertook to make a thorough study of the *Paradoxides* beds and fossils of Franklin County. He went to St. Albans, and for a month searched the rocks of the surrounding region for Paradoxidian fossils. Edson was no longer living to guide him to the outcrops from which he had gotten his fossils, and the exact localities from which fossils of this age had been collected years before were not known; but, toward the end of the month's search, fossils that appeared to belong to a *Paradoxides* fauna were discovered. These included both brachiopods and trilobites. They all came from isolated outcrops of shale and limestone conglomerate, and most of them, including those that seemed to be most probably of Paradoxidian age, came from a single small outcrop of shale in a field, known as Adams' Pasture, in the western outskirts of St. Albans. This outcrop appeared to be that of a bed stratigraphically above the limestone conglomerate in the same pasture; but later discoveries have shown that this appearance was deceptive, and that

tectonic thrusting or glacial shoving had pushed parts of the bed holding the fossils somewhat out of the normal line of strike of the bed and that it actually belongs below the conglomerate, in what is now called the St. Albans Shale, or *Centropleura* beds.

These fossils were shown to Charles Schuchert in the fall of 1922, and word of their discovery was sent to Arthur Keith before the publication of this paper.

During the following two summers, Schuchert and Keith, together with P. E. Raymond, C. O. Dunbar, and R. W. Sayles, aided by the clue given by these fossils as to the proper place to search for *Paradoxides* beds in the region, searched carefully for more fossiliferous outcrops. Their search was successful; they got more fossils, and were able to determine that the beds from which they came lay stratigraphically between a bed which they identified as the "Milton Dolomite" and the "Highgate Shale", and that the beds extended for several miles north of St. Albans and for at least a mile south of that city.

In 1925 the writer returned to St. Albans to continue the search for information regarding these elusive beds and their fossils. He traced them farther north and south, gathered evidence concerning the stratigraphic contacts at the base and the top of the formation, and collected more fossils from them. Keith and Schuchert joined him in this examination. A brief statement concerning what had been learned up to that time about the beds and their fossils was published in 1926.[6]

One of the fossils collected by the writer in 1925 was of great scientific interest, because it seemed to be the impression of a bony dermal plate of a chordate, and thus the earliest trace found up to that time of an animal belonging in the phylum that includes the vertebrates. The discovery of this fossil was announced by the writer, and its form was described by W. L. Bryant in 1926 and 1927. A description of this fossil, *Eoichthys howelli,* is found on a later page of the present paper.

The writer returned to Vermont in the summers of 1927, 1928, and 1930, in pursuit of additional information concerning the stratigraphy of the St. Albans formation and the nature of its faunas. He succeeded in tracing the surface distribution of the beds and in determining the nature of their contacts with the formations below and above them, and was able to collect many more fossils from them. In 1929, he published a description of the St. Albans beds.[7] The present paper describes the fauna which is found in them. Brief notices concerning the character

[6] B. F. Howell: *Cambrian Paradoxides beds in northwestern Vermont,* Geol. Soc. Am., Bull., vol. 37 (1926) p. 242-243.

[7] B. F. Howell: *The Cambrian Paradoxides beds of northwestern Vermont,* 16th Biennial Rept. Vermont State Geologist, for 1927-1928 (1929) p. 249-273.

and age of this fauna and information concerning some of its species were also published in 1931 and 1932.[8]

The fauna of the St. Albans formation consists, as far as is known, entirely of animals.[9] It is a large fauna, containing 1 species of crinoids, 7 species of mollusks, 8 of brachiopods, 47 of trilobites, and one of chordates. All the species appear to be new. The fauna is apparently a "*Paradoxides* fauna", in the sense in which that term is usually employed; but it is one of the most peculiar *Paradoxides* faunas known, in addition to being the most western one yet discovered in North America, for it includes only one or two species of the genus *Paradoxides*, and these are rare in it, although *Paradoxides* is the most characteristic, and one of the most abundant of the genera found in all the other *Paradoxides* beds of the world. The St. Albans fauna does have a representative of a genus, *Centropleura*, which, although equally characteristic of *Paradoxides* beds elsewhere and closely related to *Paradoxides*, is usually much less abundant than the latter genus. Examples of *Centropleura* are not uncommon in the St. Albans Shale. In having *Centropleura* a common genus and *Paradoxides* a rare one the St. Albans fauna resembles the fauna recently described by Holm and Westergaard from Bennett Island, north of Siberia.[10] Although this Bennett Island fauna is of Paradoxidian type, no specimens of *Paradoxides* have yet been found in it.

DESCRIPTION OF SPECIES

The known species of the St. Albans fauna are described herewith.

Phylum ECHINODERMA
Subphylum PELMATOZOA
Class CRINOIDEA
Subclass EOCRINOIDEA Jaekel

(Plate 6, figure 31)

In some beds of the St. Albans formation, there occur many little, more or less hexagonal, plates, from an eighth to a quarter of an inch in diameter. These plates were submitted to A. F. Foerste for examination, because of his knowledge of Cambrian echinoderms. He was unable to determine their exact relationships, but states that they show no evidence of having had the "canals, slits, or other passages

[8] B. F. Howell: *Cambrian "Paradoxides" fauna of northwestern Vermont*, Geol. Soc. Am., Bull., vol. 42 (1931) p. 346-347; *Two new Cambrian trilobites from Vermont*, Wagner Free Inst. Sci., Bull., vol. 7 (1932) p. 4-8; *Discovery of the Cambrian genus, Elyx, in America*, Geol. Soc. Am., Bull., vol. 43 (1932) p. 266-267.

[9] The alga, *Dactyloidites asteroides*, described by Dr. Rudolf Ruedemann (Geol. Soc. America, Mem. 2, 1935, p. 30) as occurring in the Late Middle Cambrian of Franklin County, Vermont, and once thought to be a member of the St. Albans flora, is now known to be an older, Parker (Early Cambrian) species.

[10] G. Holm and A. H. Westergaard: *A Middle Cambrian fauna from Bennett Island*, Acad. Sci. USSR, Mém., 8th ser., Classe Phys.-Math., vol. 21, no. 8 (1930).

indicating a water vascular system" which are characteristic of the Cystoidea, and would seem, therefore, not to be cystoids, but to be more probably referable to the group of primitive crinoids which Jaekel has called the Eocrinoidea. Foerste was unable to assign these plates to any genus; and their naming and more definite classification will have to be postponed until the discovery of better-preserved material, showing how the plates were arranged in the body of the animal, gives further information as to the animal's morphology. Examples of these plates are nos. 41252, 41255, 41256, 41258, 41260, 41261, 41263, 41264, and 41268-41286 in the Paleontological Collection of Princeton University.

Phylum MOLLUSCOIDEA
Class BRACHIOPODA
Order ATREMATA
Superfamily OBOLACEA Schuchert

Family OBOLIDAE King
Subfamily OBOLINAE Dall

Genus *Obolus* Eickwald
Obolus clarae, new species

(Plate 1, figures 1-4)

Only a few specimens of this species are known, and none of them shows the internal details clearly. They seem, however, to be referable to *Obolus* and to belong to an undescribed species. All the features that can be seen are shown in the figures. The shell was thin, and there is little convexity to the valves.

The specific name is given in honor of Mrs. Howell, who found the holotype:

OBSERVATIONS: This species seems to be close to *Obolus schmalenseei,* of the late Paradoxidian *Paradoxides forchhammeri* zone of Sweden, although it is much larger than that species. Valves of *O. clarae* can be distinguished from small valves of *Lingulella* (*Lingulepis*) *vermontensis* by their thinner shells, lesser convexity, and more rounded anterior edges.

LOCATION OF TYPES: The holotype is a ventral valve. It is no. 9672 in the paleontological collection of Princeton University. Paratype dorsal and ventral valves are nos. 9593, 9594, 9598, 9601, 9612, and 9636 in the same collection. These are the only examples of the species known.

Genus *Lingulella* Salter
Lingulella longa, new species

(Plate 1, figures 10, 11)

The outer surface of the shell is marked with well-developed concentric lines of growth. The few specimens known exhibit the internal markings only imperfectly, as shown in the illustrations.

OBSERVATIONS: This species appears to be closely related to *Lingulella collicia* (Matthew), which occurs in Middle Cambrian beds (G. F. Matthew's Divisions E2 and E3) on McLean Brook, Cape Breton, Nova Scotia. The discovery of better-

preserved specimens may make it possible to demonstrate that the Vermont form should be classified as a variety of *collicia*. It is, however, larger than *collicia*, and may differ in other details not visible in the few examples available.

It is an interesting, and perhaps significant, fact that two of the brachiopods of the St. Albans formation, this species and *Lingulella* (*Lingulepis*) *vermontensis*, described on a later page, seem to have their nearest known relations in the Middle Cambrian faunas of Cape Breton.

LOCATION OF TYPES: The holotype is a dorsal valve, no. 9648 in the paleontological collection of Princeton University. Paratype dorsal and ventral valves are nos. 9649-9655 in the same collection.

Lingulella parvula, new species

(Plate 1, figures 12, 13)

Only two examples of this species have been found. The shell is thin. The lines of growth are prominent. Both valves appear to be ventral ones. Little can be learned from them as to the internal characters of the shell.

OBSERVATIONS: This is a small species. In size and outline, its valves resemble those of *L. agnostorum* (Wallerius), of the *Paradoxides forchhammeri* zone of Sweden, but they appear not to have the peculiar uneven contour of the anterior part of the valve, which is characteristic of that species. They resemble closely the examples of "*Lingulella* (?) sp." figured by Holm and Westergaard [11] from the late Paradoxidian beds of Bennett Island, Siberia.

LOCATION OF TYPES: The holotype is no. 40134 in the paleontological collection of Princeton University. The single paratype is no. 9806 in the same collection.

Genus *Lingulella*

Subgenus *Lingulepis* Hall

Lingulella (*Lingulepis*) *vermontensis*, new species

(Plate 1, figures 5-9)

Lingulepis acuminata (Conrad), EDSON, Rept. State Geologist of Vermont for 1905 and 1906 (1906) p. 154. *Lingulepis acuminata* (Conrad), EDSON, Rept. State Geologist of Vermont for 1907 and 1908 (1908) p. 214. *Obolus* sp. Walcott, PERKINS, Rept. State Geologist of Vermont for 1907 and 1908 (1908) p. 209. *Obolus matinalis* ? WALCOTT, Mon. U. S. Geol. Surv. no. 51 (1912) p. 251, 402.

The general form and internal markings are shown in the figures. The convexity appears to be rather low, although a part of this may be more apparent than real, the shells having been flattened by pressure in the movement which the enclosing shale has undergone. There is some variation in the shape of the shells, as shown in the illustrations, but some of this, too, may be due to distortion resulting from the movement of the shale.

The shell is rather thick for that of a phosphatic shelled brachiopod, but is only what is normally found in species of such large size and in other similar species of the subgenus *Lingulepis*. The shells are distinctly marked with both longitudinal and concentric lines.

OBSERVATIONS: This is a surprisingly large species of brachiopod to be found in a *Paradoxides* fauna, where the brachiopods are usually small. It is also the only

[11] G. Holm and A. H. Westergaard: *op cit.*, pl. 3, fig. 31-33.

species of *Lingulepis* yet discovered in an undoubted *Paradoxides* fauna, although *Lingulella*, of which *Lingulepis* is a subgenus, is commonly found associated with *Paradoxides*.

Lingulepis vermontensis is characterized by its flask-shaped ventral valve. It seems to find its nearest known relative in *Lingulepis roberti*, a species of about the same, or slightly larger, size, which occurs in beds doubtfully referred to the Middle Cambrian (G. F. Matthew's zone E2a?) on Young Point, near George River station, Cape Breton, Nova Scotia. A comparison with Matthew's original cotypes of *L. roberti* shows that the Vermont species differs from the Cape Breton one in having less convex valves, which are somewhat thinner and more acuminate, and in lacking the inosculation of the striae on the surface of the shell that is characteristic of *L. roberti*. A brachiopod compared with *L. roberti* was recently recorded from Finmark, Northern Norway, by Trygve Strand,[12] who considers the fauna of which his species is a member to be probably late Paradoxidian in age.

L. vermontensis is the commonest species in the *Centropleura* fauna of Franklin County, although it is much more abundant at some localities than at others. It is possible that the specimens referred to it really belong to more than one species. Most of them have been so distorted by the movement of the enclosing beds that it is difficult to determine their finer details and to be certain of their original form. Until better specimens are collected, it seems best to assume that all the apparent differences observed are due to differences in preservation, and to refer all the specimens to the one species.

LOCATION OF TYPES: The holotype is a ventral valve, no. 9570 in the paleontological collection of Princeton University. Paratypes are Princeton nos. 9571-9592, 9595-9597, 9599, 9600, 9612-9614, 9662, 9668, 9669, and 9849; nos. 6451a-d, 6452, and 6453 in the Canadian National Museum, and nos. 13065-13078 in the paleontological collection of the Peabody Museum of Natural History, of Yale University. Paratypes have also been placed in the United States National Museum, and tophomeotypes have been deposited in the paleontological museum of the University of Vermont.

Superfamily ACROTRETACEA Schuchert
Family ACROTRETIDAE Schuchert
Subfamily ACROTHELINAE Walcott and Schuchert

Genus *Acrothele* Linnarsson
Acrothele franklinensis, new species

(Plate 1, figures 14, 15)

Only three examples of this species have been discovered. Fortunately, two are ventral valves. All three are now probably somewhat more flattened than they were in life. They show no anatomical details, except the rings of growth, which are clearly visible on both shells, and the two vascular sinuses, which can just be distinguished for a part of their length on the ventral valve, which is so preserved that its inside surface is exposed.

[12] Trygve Strand: *A Cambrian fauna from Finnmark, northern Norway*, Norsk Geol. Tidsskr., vol. 15 (1935) p. 19-24, 1 pl.

OBSERVATIONS: This is one of the wide species of *Acrothele*. In its general shape, it resembles *A. matthewi lata* Matthew; but it is apparently a smaller form than Matthew's subspecies, and probably had a somewhat less prominent beak. The discovery of more examples of the Vermont form may demonstrate that it should be classified as a variety of *A. matthewi*.

LOCATION OF TYPES: The holotype is a ventral valve. It is no. 9656 in the paleontological collection of Princeton University. The paratype dorsal valve is no. 9657 in the Princeton collection, and the paratype ventral valve is 9924 in the same collection.

Subfamily ACROTRETINAE Matthew

Genus ACROTRETA Kutorga

Acrotreta dubia, new species

(Plate 1, figures 22a-c)

This doubtful species is based on a single tiny specimen, which appears to be a ventral valve. It is so small (it is less than a millimeter wide) and is so poorly preserved that it cannot be said with certainty to be a fossil at all. But it seems probable that it is really a tiny brachiopod of this genus; and, therefore, the writer feels that it should be named, so that the attention of future students of this fauna may be called to the desirability of searching for additional and better-preserved examples, which might otherwise, because of their small size, be overlooked.

OBSERVATIONS: The small size and poor preservation of this fossil prevent the making of any detailed comparisons between it and other species. If it is really an *Acrotreta*, it is one of the smallest species of that genus, and is near to such other tiny late Paradoxidian species as *A. schmalenseei* and *A. socialis*, which are found in Sweden. It is possible that better-preserved specimens of the Vermont form would show that it should be referred to one of these two Swedish species, or to some other; but, in the absence of such evidence, and because the other brachiopods of the Vermont *Centropleura* fauna appear to be new species, it is probable that this one, too, is distinct and new.

LOCATION OF TYPE: The holotype is no. 9695 in the paleontological collection of Princeton University.

Acrotreta rara, new species

(Plate 1, figure 16)

Only six examples of this species have been found. Of these, four are fragments of what are apparently four dorsals and a ventral valve. The other is the mold of the interior of a dorsal valve.

OBSERVATIONS: Too little is known of this species to permit a comparison with others.

LOCATION OF TYPES: The holotype is no. 9785a in the paleontological collection of Princeton University. Its counterpart is no. 9785b. The other five paratypes are nos. 9805, 9982, 41080, 41081, and 41123 in the same collection.

Order PROTREMATA

Superfamily ORTHACEA Walcott and Schuchert
Family BILLINGSELLIDAE Schuchert
Subfamily NISUSIINAE Walcott and Schuchert

Genus *Protorthis* Hall and Clarke
Protorthis vermontensis, new species

(Plate 1, figures 17-20)

Six specimens of a small Billingsellid brachiopod were found in the St. Albans Shale.

The best of these is a dorsal valve, of which the molds of its outer and inner surfaces (figures 18 and 19) are preserved. This specimen is similar in most of its characters to small shells of *Protorthis billingsi* (Hartt), which is a member of the early Paradoxidian Cambrian *Paradoxides eteminicus* fauna of New Brunswick, Canada. It appears to differ from that species, however, in having a somewhat smaller number of ribs, in being a little more convex, and in showing no trace of a sinus.

A second specimen is a smaller shell, probably also a dorsal valve of the same species, but badly flattened and distorted (figure 20).

Of the other four specimens, two are nearly entire shells and the other two are fragmentary half shells. Three of these are so poorly preserved that it has not been possible to determine whether they belong to the same species as the first two or not. One of the nearly entire shells (Pl. 1, fig. 21) appears to have an outline more like that of a Linguloid brachiopod than like that of a Billingsellid, but this appearance may be due to distortion. Its ribs and those of one of the fragments seem to be narrower and closer together than they are in the first specimen referred to; but the surface ornamentation and nature of the two shells seem to be the same as they are in the first specimen; and, as ribbed brachiopods are comparatively rare in Cambrian rocks, and ribbed shells of Linguloid shape are unknown in beds of that period, it seems probable that all four valves are referable to a single species. Although this species resembles *Protorthis billingsi* in general appearance, the six known specimens are all so much smaller than the average shell of that species that it seems likely that the two forms differed much in size, if little in other respects. This fact, and the difference in age between the two (*P. billingsi* being much older than the Vermont form), indicate that they are distinct species.

Four of the six known specimens of this species are figured, and their characters, including the characteristic, well-developed lines of growth and punctae can be seen in the illustrations.

OBSERVATIONS: This species is one of the rarest members of the St. Albans fauna. No closely related species that can now be proved to be of approximately the same age is known.

The writer gratefully acknowledges assistance given to him by Dr. Ira Edwards, of the Milwaukee Public Museum, in the determination of the relationships of this species.

LOCATION OF TYPES: The entire dorsal valve, which is so preserved that the molds of its outer and inner surfaces are available, has been chosen as the holotype. It is no. 9676 (*a* and *b*) in the paleontological collection of Princeton University. Para-

types are nos. 5710, 9677, 9678, and 9913 in the Princeton collection (three of them the specimens doubtfully referred to this species) and 13401 in the paleontological collection of the Peabody Museum of Natural History of Yale University (the small valve).

Phylum MOLLUSCA
Class GASTROPODA
Order ASPIDOBRANCHIA
Suborder DOCOGLOSSA Troschel

Family PALAEACMAEIDAE Grabau and Shimer

Genus *Helcionella* Grabau and Shimer

Helcionella vermontensis, new species

(Plate 2, figure 1)

Only the single holotype specimen of this species has been found. All that is known of its shape is shown in the figure of it which is presented. The concentric ridges on the outer surface of the shell are so low as to be difficult to distinguish. The shell flares outward at the aperture.

OBSERVATIONS: This species is possibly not a *Helcionella*. With present imperfect knowledge of it, however, this appears to be the genus in which it belongs.

LOCATION OF TYPE: The holotype is no. 40200a in the paleontological collection of Princeton University.

Helcionella americana, new species

(Plate 3, figure 1)

Only the holotype is known. All that can be seen of its form is shown in the illustration. The apex is acutely pointed. The concentric ridges are strongly developed.

OBSERVATIONS: This species differs from *Helcionella vermontensis* in the shape of the shell, in having more prominent concentric ridges, and (as far as can be determined from the single known specimen) in lacking the outward flare of the shell at the aperture. It is possible that the species should not be referred to *Helcionella*. It appears, however, to be similar to the Chinese Medial Cambrian species, which Walcott described as *Helcionella rugosa orientalis*.

LOCATION OF TYPE: The holotype is no. 40243 in the paleontological collection of Princeton University.

Suborder RHIPIDOGLOSSA Troschel

Family EUOMPHALIDAE de Koninck

Genus *Straparollina* Billings

Straparollina vermontensis, new species

(Plate 2, figure 2)

A single poorly preserved coiled gastropod shell, which seems to be referable to *Straparollina*, and is probably a new species, has been found in the St. Albans formation. All that can be seen of its characters is visible in the figure.

OBSERVATIONS: The single specimen on which this species is based is too poorly preserved to permit of comparison with other species. As no similar species is known to have been described from any fauna closely resembling the St. Albans, however, it seems probable that the Vermont form is new.

LOCATION OF TYPE: The holotype is no. 9933 in the paleontological collection of Princeton University.

Class PTEROPODA

Family HYOLITHIDAE Nicholson

Genus *Hyolithes* Eichwald

Hyolithes rarus, new species

(Plate 2, figure 3)

Only a single operculum is known. All that can be determined concerning its character is shown in the illustrations which are presented.

OBSERVATIONS: It is possible that this operculum belongs with the shell which is described below as *Orthotheca vermontensis;* but this seems improbable, for the operculum appears to have the bent form characteristic of the opercula of *Hyolithes,* rather than the flat form of an *Orthotheca* operculum; the shell on which the species *Orthotheca vermontensis* is based appears probably to have had the form of the genus to which it is referred, rather than that of a *Hyolithes.*

LOCATION OF TYPE: The holotype is no. 40240 in the paleontological collection of Princeton University.

Genus *Orthotheca* Novák

This genus differs from *Hyolithes* in that the aperture of the shell is not extended on one side, and in that the operculum is consequently nearly flat, and not bent down on one side, as it is in *Hyolithes.*

Orthotheca has commonly been classified as a subgenus of *Hyolithes;* but it is believed that it deserves full generic rank.

Orthotheca acicula, new species

(Plate 2, figure 4; Plate 4, figure 29)

All that is known of the form of this species is shown in the figures of the only two specimens that have been found, which are illustrated. The outer surface of the shell appears to have been smooth. In cross-section the shell is subrectangular. The operculum is not known.

OBSERVATIONS: This species is remarkable for the small diameter and the great length of its shell and for the fact that the shell is subrectangular in cross-section. It somewhat resembles in form *Hyolithes* (*Orthotheca*) *quadrangularis* Holm, of the Lower Ordovician of Sweden. It may possibly, therefore, belong in Holm's subdivision, Quadrangulares, of the "subgenus" *Orthotheca,* although too little is known of the Vermont species to enable us to determine its relationships with any certainty.

LOCATION OF TYPES: The holotype is no. 9937 in the paleontological collection of Princeton University. The single known paratype is no. 40239 in the same collection.

Orthotheca vermontensis, new species

(Plate 2, figure 5)

Only the single shell which is figured has been found. As far as can be determined from this specimen the shell was nearly, or quite, circular in cross-section; but, as only half of the shell can be seen, one cannot be certain about this feature. Nothing can be determined from the specimen about the character of the outer surface of the shell.

OBSERVATIONS: It is possible that this species should be referred to *Hyolithes*, rather than *Orthotheca*. The aperture of the shell is not preserved, so that the genus cannot be determined with certainty. It is placed in *Orthotheca*, because that genus is more common than *Hyolithes* in the late Paradoxidian faunas.

LOCATION OF TYPE: The holotype is no. 40241 in the paleontological collection of Princeton University.

Orthotheca dubia, new species

(Plate 2, figure 6)

This species is based on the single poorly preserved operculum which is figured. All that can be determined about its characters can be seen in the illustration. The ridges are prominent, but run only half way across the operculum. There is a well-developed hollow between the ridges.

OBSERVATIONS: It is possible that the specimen on which this species is based is an operculum of *Orthotheca vermontensis*. This seems improbable, however, because the operculum is considerably larger than the aperture of the shell on which the species *Orthotheca vermontensis* is founded.

LOCATION OF TYPE: The holotype is no. 40242 in the paleontological collection of Princeton University.

Phylum ARTHROPODA
Class CRUSTACEA
Subclass TRILOBITA
Order AGNOSTIA

Family SPINAGNOSTIDAE Howell

Spinagnostus franklinensis Howell

(Plate 2, figures 9, 10, 11, 13, 14)

Spinagnostus franklinensis HOWELL, Jour. Paleont., vol. 9 (1935) p. 219, pl. 22, figs. 1-5.

CEPHALON: The brim and the anterior groove are both broad. There is no trace of the frontal lobe of the glabella, but the main lobe is long and well defined all around. There is seldom any trace of the transverse furrow, the main lobe being usually well rounded in front. There is a small spine at each of the rear corners of the shield. The convexity is moderate. The test is smooth. Young cephala appear not to differ from adult ones in form.

THORAX: The bosses and furrows are not strongly developed.

PYGIDIUM: The flange is rather wide, and is armed with two stout spines. The axis is well defined by the dorsal furrow, but there are no traces of transverse furrows, and the tubercle, although present, is not conspicuous. The axis is bluntly pointed at the rear, and reaches to the posterior groove, separating the pleural lobes. The convexity of the shield is moderate. The test is smooth. In young pygidia the axis is shorter and narrower than in adult ones, and the pleural lobes are confluent behind it.

OBSERVATIONS: This is one of the commonest species in the *Centropleura* beds of northwestern Vermont. It is the commonest Agnostian in those beds.

LOCATION OF TYPES: The holotype is a cephalon, no. 9679a in the paleontological collection of Princeton University. Paratypes are nos. 9680-9702, 9808, 40199, and 40201 in that collection, nos. 13402-13408, 13432, 13424, and 13437 in the paleontological collection of the Peabody Museum of Natural History of Yale University, nos. 91933 and 91934 in the paleontological collection of the United States National Museum, and nos. 6454a-d and 6455 in the Canadian National Museum. Tophomeotypes have also been deposited in the paleontological collections of the University of Vermont; the Redpath Museum of McGill University, in Montreal; the Walker Museum of the University of Chicago; the University of Alberta; Columbia University and the American Museum of Natural History, in New York; the Museum of Comparative Zoology of Harvard University, in Cambridge; the British Museum and the museum of the Geological Survey of Great Britain, in London; the Sedgwick Museum of Cambridge University; the geological museum of the University of Sheffield; the museum of the Geological Survey of Denmark, in Copenhagen; the museum of the Geological Survey of Sweden, in Stockholm, the paleontological museum of the University of Lund, in Sweden; the Národní Museum, in Prague; the museum of the Geological Survey of Poland, in Warsaw; the paleontological museum of the University of Göttingen, the Senckenberg Museum, in Frankfort, Germany, the paleontological collection of the Geologisch-Paläontologisches Institut und Museum of the University of Berlin; and the paleontological museum of the University of Montpellier, in France.

There are two other species of the family Spinagnostidae in the St. Albans formation. Both appear to belong to different subfamilies and genera from *Spinagnostus franklinensis,* and one of the genera and one of the subfamilies are new. The subfamily and genus are defined below.

Subfamily ARMAGNOSTINAE, new subfamily

Cephalon with both lobes of the glabella well defined, and with a broad brim, which tends to give the shield a subquadrate form. Pygidium with the axis well defined by the dorsal furrow, but with the transverse furrows weakly or only partly developed. The flange is broad at the rear, and bears large, but not long, spines, so that the whole pygidium has a subquadrate appearance.

Genus *Armagnostus,* new genus

The characters of this genus are those of the subfamily Armagnostinae.
The genotype is *A. megalaxis.*

Armagnostus megalaxis, new species

(Plate 2, figures 12, 15, 16)

CEPHALON: The axial and transverse furrows are distinct, but not deep where the shield is preserved in shale and somewhat flattened. Where the cephalon is pre-

served unflattened the transverse furrow is faint. The basal lobes are well developed. There is a tubercle on the main lobe of the glabella, but it is not prominent. The test is smooth. The convexity is moderate.

THORAX: Unknown.

PYGIDIUM: The convexity is moderate, and the test is smooth. The axis is large, is somewhat expanded in its rear half, and is so long that it separates the pleural lobes widely at the rear. The dorsal furrow is strongly developed, but the transverse furrows are practically obsolete. There is a tubercle on the middle lobe of the axis, but it is not prominent. The posterior groove, the flange, and the spines are well developed.

OBSERVATIONS: This species is rare in the St. Albans formation. Only nine examples of it have been found. The pygidia somewhat resemble those of *Spinagnostus franklinensis;* but they differ from the pygidia of that species in having the axis wider and more rounded at the rear, and the whole rear end of the shield more subquadrate in form, with more prominent spines. *Armagnostus megalaxis* is also a much larger species than *Spinagnostus franklinensis.*

LOCATION OF TYPES: The holotype is a pygidium, no. 9786 in the paleontological collection of Princeton University. The other known specimens are paratypes, nos. 5767, 9787-9792, 41084, 41099, 41124, and 41288 in the same collection. Squeezes of paratype 9788 are no. 6460 in the Canadian National Museum and no. 13413 in the Peabody Museum of Natural History of Yale University. A similar squeeze has been deposited in the United States National Museum.

Subfamily QUADRAGNOSTINAE, Howell

Quadragnostus solus Howell

(Plate 2, figures 17, 18)

Quadragnostus solus HOWELL, Jour. Paleont., vol. 9 (1935) p. 219-220, pl. 22, figs. 6, 7.

CEPHALON: The frontal lobe of the glabella is rounded in front, and the main lobe is indented on the side about half way along its length. The transverse furrow is strongly arched backward.

THORAX: Unknown.

PYGIDIUM: The axis is long and narrow, and separates the pleural lobes at the rear. It shows only faint traces of transverse furrows. The tubercle is high, and is much elongated. It is keel-shaped. The pleural lobes and flange are wide, and there are large spines on the flange, so that the whole shield has a broad and subquadrate appearance. The convexity of the shield is moderate, and the surface is smooth.

OBSERVATIONS: Only five examples of this species—all but one, pygidia—have been discovered. It must have been a rare member of the St. Albans fauna. It is possible, but not probable, that the cranidium assigned to this species belongs to some other Agnostian—either *Armagnostus megalaxis* or an unnamed species, as its frontal glabellar lobe is less quadrate than might be expected of the cephalon of a species with a pygidium such as the one of which *Quadragnostus solus* is founded.

LOCATION OF TYPES: The holotype is no. 9793 in the paleontological collection of Princeton University. The four paratypes are nos. 9794, 9943, 40091, and 40126 in the same collection.

There is another species of Agnostian, which is found rarely in the St. Albans formation. It belongs to still another branch of the order, and requires the erection of a new family, subfamily, and genus for its reception. They are characterized, and the species is described, as follows:

CLAVAGNOSTIDAE, new family

The glabella has only a single lobe, which is ovally rounded or bluntly pointed in front. The pygidium has a long, wedge-shaped, or lanceolate, axis, which separates the pleural lobes at the rear. There are spines at the rear corners of both shields. These spines are short in some species, and long in others.

The family is known to range from the late Middle Cambrian into the Upper Cambrian.

CLAVAGNOSTINAE, new subfamily

The characters of this subfamily are those of the type genus. The known members of the subfamily are small in size.

The subfamily is known only from the uppermost Middle Cambrian.

Clavagnostus, new genus

The glabella is ovally pointed in front. The axis of the pygidium is lanceolate. The spines at the rear corners of both shields are short.

The genus is known to occur in the late Middle Cambrian beds of North America, Scandinavia, and Bennett Island, north of Siberia.

The genotype is *Agnostus repandus* Holm and Westergaard.[18]

Clavagnostus aequalis, new species

(Plate 2, figure 19)

Only the pygidium is known, and only two certain and one doubtful examples of that have been discovered. It is small—only 2½ millimeters long. Its flange is of medium width at the sides, but is somewhat wider across the rear. It bears no distinct spines at its rear corners, but appears to have tiny ones, which are difficult to distinguish clearly. The axis is lanceolate, a little expanded in its middle third, and prolonged into a long, sharp point behind, where it separates the pleural lobes and reaches the dorsal furrow. It bears an elongate tubercle.

OBSERVATIONS: The single known pygidium of this species resembles that of *Clavagnostus repandus* Holm and Westergaard, which occurs in the *Paradoxides forchhammeri* beds of Sweden and the *Centropleura* beds of Bennett Island, north of Siberia, but differs from that species in having a narrower axis and less well developed spines on the flange.

LOCATION OF TYPES: The holotype is no. 5768 in the paleontological collection of Princeton University, and the two paratypes are 41287 and 41288 in the same collection.

Family HASTAGNOSTIDAE, new family

There is a medial furrow on the cephalon. The pleural lobes are either divided or confluent at the rear. The glabella is bilobed, long, narrow, and bluntly pointed

[18] G. Holm and A. H. Westergaard: *op. cit.*, p. 13-15, pl. 1, fig. 35-39 (40-43 ?); pl. 4, fig. 11, 12.

in front. The axis of the pygidium is trilobed, bears a prominent and elongate tubercle, and is more or less bluntly pointed at the rear. The transverse furrows are well developed. The brim and the flange are narrow, and there are no spines on the flange.

The family is, as far as known, confined to the Medial Cambrian Epoch, through most of which time it ranged.

Subfamily HASTAGNOSTINAE, new subfamily

This subfamily includes those members of the Hastagnostinae whose pleural lobes are divided at the rear.

Genus *Hastagnostus*, new genus

In this genus the axis of the pygidium is long and narrow, and is more bluntly rounded at the rear than in other genera of the subfamily Hastagnostinae.

The genotype is *Hastagnostus angustus*.

Hastagnostus angustus, new species

(Plate 3, figs. 3, 4)

Agnostus sp., EDSON, Rept. State Geologist Vermont for 1905 and 1906 (1906) p. 152.

CEPHALON: The medial furrow and transverse furrows are distinct, although not deeply impressed. The convexity is medium. The test is smooth.

THORAX: The bosses and furrows of the axis are well developed, especially on the front segment.

PYGIDIUM: The axis is long and narrow, and reaches so far back that it almost touches the posterior groove. The transverse furrows on the axis are clearly defined, and there is an elongate tubercle on the second lobe. The rear end of the axis is bluntly pointed. The surface of the test is smooth.

OBSERVATIONS: This species is characterized by its long, narrow, pygidial axis and the fact that the rear end of the axis is more than usually rounded. The species is a rare one. Possibly not all the specimens here referred to it actually belong in it.

LOCATION OF TYPES: The holotype is an entire test, no. 9795 in the paleontological collection of Princeton University. Paratypes are Princeton nos. 9796, 9883, 9884, 9910, 40067, 40246, 41082, and 41289, and nos. 13414 and 13415 in the paleontological collection of the Peabody Museum of Natural History of Yale University.

There are two other Agnostians in the St. Albans fauna. They also belong to different families, subfamilies, and genera from the other four members of the order that are associated with them. They and their genera are described herewith. The first of them is believed to belong in a new family and subfamily.

Family CYCLOPAGNOSTIDAE, new family

The glabella has no frontal lobe, and the main lobe is ovally rounded anteriorly. The axis of the pygidium is short, and is ovally rounded at the rear. The transverse furrows on it are faint or obsolete. The brim and flange are of only moderate width, and there are no spines on the flange.

Subfamily CYCLOPAGNOSTINAE, new subfamily

This subfamily is characterized by having the furrows on the axis of the pygidium obsolete.

Genus *Cyclopagnostus*, new genus

The characters are those of the subfamily Cyclopagnostinae, of which this is the only known genus.

The genotype is the new species, *Cyclopagnostus hesperius*, to be described. *"Agnostus" brevifrons* Angelin,[14] which was a member of the late Paradoxidian Cambrian *Paradoxides forchhammeri* fauna of Scandinavia, is also believed to be referable to this genus.

Cyclopagnostus hesperius, new species

(Plate 2, figure 20; Plate 3, figure 2)

CEPHALON: The glabella is only faintly outlined by the dorsal furrow, and hardly rises above the general level of the shield. There is a small tubercle, well forward on the glabella. The basal lobes are small. The surface of the shield is smooth. The convexity of the whole shield is rather low.

THORAX: Unknown.

PYGIDIUM: The axis is a little better defined by the dorsal furrow, and stands a little higher above the general level of the shield, than in the glabella. The tubercle, too, is less inconspicuous than the one on the cephalon. The convexity of the whole shield is only a little greater than that of the head shield. Young pygidia have the axis considerably smaller than adult ones.

OBSERVATIONS: This is a rare species in the St. Albans formation, only six specimens of it having been discovered. It resembles *Cyclopagnostus brevifrons*, of Scandinavia, but differs from that species in that its glabella is shorter and more quadrate in form and is less distinctly outlined.

The cephalon of this species resembles in general form that of *Spinagnostus franklinensis*, but differs in that the glabella is much less strongly outlined by the dorsal furrow.

LOCATION OF TYPES: The holotype is a pygidium, no. 9796 in the paleontological collection of Princeton University. The only other examples of the species known are paratypes, nos. 9797-9799, 40002, 40120, and 40187 in the same collection.

PHALACROMIDAE Corda

Grandagnostus vermontensis, new species

(Plate 3, figures 5, 6, 8, 9)

CEPHALON: Only faint traces of the basal lobes and the rear ends of the dorsal furrow are ever visible, and even these cannot be seen on most of the specimens. There is no clearly developed brim on any of the known adult cephala, all of which are exfoliated, nor do exfoliated young cephala exhibit any; but a single small unexfoliated shield that is probably referable to this species has a narrow brim.

[14] N. P. Angelin: *Palaeontologia Scandinavica* (1878) p. 6, pl. 6, fig. 4.

There is a distinct median tubercle. The convexity of the shield is rather low. The test is smooth.

THORAX: Only the axis is known. It is smooth.

PYGIDIUM: About as convex as the cephalon. Shows no trace of a dorsal furrow. Has a well-developed flange. The test is smooth.

OBSERVATIONS: This species appears to differ from *Grahdagnostus glandiformis* in having the shields shorter in proportion to their width and somewhat less quadrate in form, and in being smaller in size. The flange on the pygidium seems also to be relatively not so wide as in *glandiformis*. These differences may, however, be due to the form of preservation of the specimens, as specimens of this or a closely related species, more resembling *glandiformis* (except that they are not as large as that species) occur in pebbles in the Mill River Conglomerate, above the St. Albans Shale. It is possible that new information may show that *vermontensis* should be considered to be a variety of *glandiformis*, rather than a distinct species. No trace of the remarkable doublures present on *glandiformis* and described by G. Holm and A. H. Westergaard[15] were found on any of the specimens of *vermontensis* collected from the St. Albans Shale, but they are present on specimens found in pebbles in the overlying Mill River Conglomerate.

Grandagnostus vermontensis is, although smaller than *G. glandiformis*, nevertheless, large for an Agnostian, being one of the largest species of the order yet discovered. It is not nearly as common in the St. Albans Shale as *Spinagnostus franklinensis*, but is much more frequently found than are the other five species of Agnostians present in the formation, all of which are rare.

LOCATION OF TYPES: The holotype is a cephalon, no. 9736 in the paleontological collection of Princeton University. Paratypes are nos. 9737-9757, 9837, 9850, and 9851 in the Princeton collection, nos. 13409-13412 and 13422 in the Peabody Museum of Natural History of Yale University, nos. 91929-91932 in the United States National Museum, and nos. 6456-6459 in the Canadian National Museum. Tophomeotypes have also been placed in the paleontological museum of the University of Vermont, the Walker Museum of the University of Chicago, the Národní Museum in Prague, and the paleontological collection of the Geological Survey of Denmark.

Order OPISTHOPARIA

All the remaining species of trilobites in the St. Albans fauna belong in the order Opisthoparia. Of this order the most primitive known family is the Conocoryphidae. Two fragments of cranidia have been found in the St. Albans formation that appear to be referable to species of this family. These fragments are so poorly preserved that they would hardly deserve to be discussed here were it not for the fact that better-preserved cranidia of what is probably the same species as one of them are found in pebbles of limestone in the Mill River Conglomerate, which overlies the St. Albans formation, and that there is good reason to believe that they represent two members of the St. Albans fauna.

The Mill River formation, which is separated from the underlying St. Albans Shale by a disconformity, is of Neo-Cambrian age, and its matrix holds Neo-Cambrian fossils. In this matrix, however, are pebbles of a gray limestone, which contain fossils that are similar to, or exactly like, some of those found in the St.

[15] G. Holm and A. H. Westergaard: *op. cit.*, p. 11, pl. 4, fig. 1-3.

Albans Shale. Very little limestone like these pebbles has been found in the St. Albans formation, and, where found, it is only in thin lenses; so it is probable that the beds from which the pebbles came lay either east or west of the thin belt of the St. Albans Shale, which is now exposed at the surface, and which certainly represents only a part of the lateral extent of that formation.

The Conocoryphid which has been found in both the St. Albans Shale and the Mill River Conglomerate appears to be referable to the genus, *Elyx*, which has heretofore been known only from the late Paradoxidian Cambrian *Paradoxides forchhammeri* zone of Scandinavia, where it is represented by a single species, *Elyx laticeps* Angelin. This species has been referred by G. F. Matthew[16] and K. A. Grönwall[17] to the genus *Ctenocephalus* Corda. Matthew[18] proposed the subgenus *Harttella* for those species of *Ctenocephalus* in which the front of the fixed cheek sloped down gently, instead of being perpendicular. Although he did not specifically refer *Elyx laticeps* to this subgenus, he doubtless intended it to be included in it. The present writer, however, believes that, because the fixed cheeks of the species of *Elyx* are broader and more quadrate than those of the other species referred to *Harttella*, and because *Elyx* is a late Paradoxidian genus, whereas *Harttella* is, as far as is known, limited to early Paradoxidian times, the genus *Elyx* is a valid genus. The Vermont species is, therefore, classified as an *Elyx*.

The writer believes that the family Conocoryphidae should be subdivided into two subfamilies. One of these subfamilies he believes should contain those species of the Conocoryphidae which have a hemispherical swelling in front of the glabella and which have been placed by authors in the past in the genera *Ctenocephalus*, *Harttella*, and *Elyx*. He has proposed the name, Ctenocephalinae, for this subfamily. The other species of the Conocoryphidae he would place in a new subfamily, the Conocoryphinae. This new classification has already been suggested in print.[19]

The Vermont species and their genera and subfamilies may, then, be classified as follows:

Family CONOCORYPHIDAE Angelin

Characterized by having a triangular glabella, wide fixed cheeks, narrow free cheeks, and a small, ribbed, pygidium.

Subfamily CONOCORYPHINAE, new subfamily

Characterized by the absence of a hemispherical swelling in front of the glabella.

Genus *Conocoryphe* Corda

The glabella tapers toward the front, and the marginal furrow is strongly developed.

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[16] G. F. Matthew: *Studies on Cambrian faunas: No. 4: Fragments of the Cambrian faunas of Newfoundland*, Roy. Soc. Canada, Tr., 2nd ser., vol. 5, sect. 4 (1899) p. 88.

[17] K. A. Grönwall: *Bornholms Paradoxideslag og deres Fauna*, Danmarks Geologiske Undersøgelse, II Raekke, no. 13 (1902) p. 101.

[18] G. F. Matthew: *Illustrations of the fauna of the St. John group, continued: on the Conocoryphea, with further remarks on Paradoxides*, Roy. Soc. Canada, Tr., vol. 2, sect. 4 (1885) p. 103.

[19] B. F. Howell: *Two new Cambrian trilobites from Vermont*, Wagner Free Inst. Sci., Bull., vol. 7 (1932) p. 4-6.

B. F. Howell: *Discovery of the Cambrian trilobite genus Elyx in America*, Geol. Soc. Am., Bull., vol. 43 (1932) p. 266-267.

Conocoryphe? artagena, new species

(Plate 3, figure 7)

This species is known only from the fragment of a cranidium which is figured, and little information can be added here to that which can be gotten from an examination of the figure. The fragment is distorted so that the fixed cheek appears to be narrower than it actually is; but it seems, nevertheless, to have been narrow for a *Conocoryphe*. It is not possible to determine from the specimen whether the surface of the test was originally smooth or was covered with tubercles.[20]

OBSERVATIONS: This fragment looks a little like part of a pygidium, but it is believed to be a cranidium. It is possible that it is not a *Conocoryphe*, but it does not seem referable to any of the other species of the St. Albans fauna.

LOCATION OF TYPE: The holotype is no. 9925 in the paleontological collection of Princeton University.

Subfamily CTENOCEPHALINAE, new subfamily

Characterized by the possession of a hemispherical swelling in front of the glabella.

Genus *Elyx* Angelin

The fixed cheeks are very wide and tend to be more rectangular, and less triangular, than they are in *Ctenocephalus* and *Harttella*. They are more evenly convex than in *Harttella*, although they resemble the cheeks of that genus and differ from those of *Ctenocephalus* in sloping gradually, not perpendicularly, toward the front. The slope is less abrupt in *Elyx* than it is in *Harttella*.

Elyx americanus Howell

(Plate 3, figures 10, 11)

Elyx americanus, n. s., HOWELL, Wagner Free Inst. Sci., Bull., vol. 7 (1932) p. 4-6.
Elyx americanus, HOWELL, Geol. Soc. Am., Bull., vol. 43 (1932) p. 266-267.

Only the cranidium is known.

The glabella shows only faint traces of glabellar furrows. The surface of the shield is smooth. All the other visible characters are clearly shown in the figures.

OBSERVATIONS: Although this species is known from only three imperfect specimens, it is possible to make some comparisons between it and the one other known species of the genus, *Elyx laticeps* Angelin. Such a comparison shows that the Vermont species has the glabellar furrows less well developed and the glabella somewhat narrower than is the case with the Scandinavian form. When better-preserved examples of *E. americanus* are discovered, other differences will probably be found.

LOCATION OF TYPES: The holotype is no. 9880a in the paleontological collection of Princeton University. It is from a pebble in the Mill River Conglomerate. Another specimen, from a pebble in the same conglomerate, is a paratype, no. 9882 in the same collection. The fragment from the St. Albans Shale that is believed also to be referable to this species is no. 9881 in the Princeton collection.

[20] It is possible that this species is referable to one of the other genera of the Conocoryphidae, but the single specimen on which it is based is too imperfect to permit certain generic reference. For a discussion of the genera of the family *see* C. E. Resser: *New species of Cambrian trilobites of the family Conocoryphidae*, Jour. Paleont., vol. 11 (1937) p. 39-42, pl. 7.

The largest, and, therefore, the most conspicuous, although not the most abundant, of the species of trilobites in the St. Albans fauna is a member of the family Paradoxidae. This family contains those species which authors have placed in the genera, *Paradoxides* and *Centropleura*. The writer believes that these two groups are of subfamily rank, and has, therefore, proposed that the families, Paradoxinae and Centropleurinae, be erected for them. Believing that the species of each of these families should be grouped in several genera, he has proposed such a grouping for the Centropleurinae,[21] he is now at work on the problem of the proper grouping of the species of Paradoxidinae, and hopes to publish the results of his studies at an early date.

The single species of the subfamily Centropleurinae which has been found in the St. Albans fauna has the palpebral lobes curved in an uneven arc and not reaching all the way to the rear corners of the cranidium. It is, therefore, here referred to *Centropleura*.

The Vermont species of the Paradoxidae are, then, characterized and classified as follows:

Family PARADOXIDAE Emmrich

Characterized by having a large glabella, whose anterior position is expanded and broadly rounded in front, rather long genal spines on the free cheeks, rather large palpebral lobes, a long and tapering thorax, and a rather small pygidium, which may or may not bear spines.

The family is confined, as far as known, to the Medial Cambrian Epoch and to the North Atlantic region.

Subfamily CENTROPLEURINAE Angelin

Characterized by having the brim extending far to each side, whereas the facial suture cuts deeply in toward the glabella, making a deep indentation in the cranidium behind the brim, by having a short anterior glabellar furrow, running diagonally back into the forward portion of the glabella on each side, and by having a relatively large pygidium with more than one spine on each side of it.

This subfamily differs from the Paradoxinae in all the characters already mentioned, except that one species of the latter subfamily (*Paradoxides ölandicus*) has more than one spine on each side of the pygidium.

Genus *Centropleura* Angelin

In this genus the palpebral lobes curve backward in an uneven arc and do not extend all the way back to the rear corners of the cranidium.

Centropleura vermontensis Howell

(Plate 3, figures 14-19; Plate 5, figure 35)

Paradoxides sp., PERKINS, Rept. State Geologist of Vermont for 1907 and 1908 (1908) p. 209.

Paradoxides harlani Green, WALCOTT, Cambrian Geology and Paleontology, No. 6—Olenellus and Other Genera of the Mesonacidae, Smithsonian Miscellaneous Collections, vol. 53, no. 6 (1910) p. 254, 255, text figs. 10, 11.

Paradoxides sp., WALCOTT, Cambrian Brachiopoda, Monograph U. S. Geol. Survey, No. 51 (1912) p. 251.

Centropleura sp., HOWELL, Geol. Soc. Am., Bull., vol. 42 (1931) p. 346-347.

[21] B. F. Howell: *The classification of the trilobite subfamily, Centropleurinae*, Meddelelser fra Dansk Geol. Forening, vol. 8 (1933) p. 215-219.

Centropleura vermontensis, n. s., HOWELL, Bulletin, Wagner Free Inst. Sci., vol. 7 (1932) p. 4-6.
Centropleura vermontensis HOWELL, Geol. Soc. Am., Bull., vol. 43 (1932) p. 266-267.

CRANIDIUM: The glabella is evenly rounded in front. The second and third glabellar furrows are less deeply impressed than are the fourth furrow and the neck furrow. In young cranidia the second and third furrows are and do not extend all the way across the glabella, but are interrupted along the middle line; but in most of the adult cranidia, they go completely across, although they are usually faint in the middle third of their course.

FREE CHEEKS: Nothing but fragments of the free cheeks have been found, but the cheeks were presumably similar to those of *Centropleura loveni*, whose cranidium resembles that of the Vermont species in most of its characters.

HYPOSTOME: The characters of the hypostome can be seen in the illustrations.

THORAX: The thorax is known only from fragmentary single pleura and one fragmentary axis, which appears to be referable to this species. It appears to have been similar to the thorax of *C. loveni*.

PYGIDIUM: The pygidium has two spines on each side. The axis is about half as long as the whole shield. The ribs and furrows on the pleural lobes and the three transverse furrows on the axis are only weakly developed.

OBSERVATIONS: The species differs from *Centropleura loveni* in having the front of the glabella evenly rounded, instead of somewhat ovally pointed, and in having the second and third glabellar furrows impressed across the middle line of the glabella. Some of the specimens here referred to this species may perhaps not belong in it, as they are poorly preserved; but no good evidence that they are referable to another species has been observed. Some young cranidia of *C. vermontensis* are like adult cranidia of *C. loveni* in having the second and the third glabellar furrows obsolete in the middle third of their course. *C. vermontensis* may, therefore, be a somewhat more recent species than *C. loveni*.

The adult hypostome of *C. vermontensis* appears to differ from that of *C. loveni* in being more elongate in form, and in having the two posterior wings smaller. The imperfect preservation of the few known hypostomes of *C. vermontensis*, however, makes it difficult to determine with certainty how different the two really are.

LOCATION OF TYPES: The holotype is a cranidium, no. 9809 in the paleontological collection of Princeton University. Paratypes are nos. 9810-9817, 9819-9836, 9838-9848, 9876, 9939, 9996, 9997, 40059, 40061, and 41071 in the Princeton collection, and 13416-13420 and 13435 in the paleontological collection of the Peabody Museum of Natural History of Yale University.

At least one other species of the family Paradoxidae occurs rarely in the St. Albans fauna. It is apparently a member of the group of species of the subfamily Paradoxinae that includes the type species of the genus *Paradoxides, P. tessini*, and is, therefore, a true *Paradoxides*. It is a new species. It and its subfamily and genus are characterized as follows:

Subfamily PARADOXINAE, new subfamily

The palpebral lobe may be long or short, but the facial suture does not cut into the cranidium in such a way that the brim extends far to the sides as a narrow arm of the shield, as it does in the Centropleurinae. There is no anterior glabellar furrow running diagonally back into the forward portion of the glabella on each side. The pygidium ordinarily has only one spine on each side, and is smaller than in the Centropleurinae.

Genus *Paradoxides* Brongniart

The glabella is relatively short and straight across the front, as though the anterior part of it had been pressed backward. The palpebral lobes are rather long, but do not reach all the way back to the rear corners of the cranidium.

The genotype is *Paradoxides tessini* Brongniart.[23]

Paradoxides franklini, new species

(Plate 3, figures 12, 13)

CRANIDIUM: The glabella is much flattened, backward, so that it is almost straight across the front. The posterior glabellar furrow is deeply impressed, and must have extended all the way across the glabella. The one anterior to it is faint, and did not extend all the way across. The one in front of that is not quite so faint in the single cranidium of this species known, and does not extend all the way across the glabella. This last furrow runs inward from the anterior end of the palpebral lobe, and there is no trace of a furrow anterior to it. The palpebral lobe is rather narrow.

FREE CHEEKS: Four free cheeks and a cheek spine, which are thought to be referable to this species, are figured. All that is known of their characters can be seen in the illustrations.

HYPOSTOME: No hypostome that seems to belong to this species has been discovered.

THORAX: A single thoracic segment that may possibly be referable to this species has been found. It is figured.

PYGIDIUM: Unknown.

OBSERVATIONS: This species differs from the Scandinavian species, *Paradoxides tessini*, in having the front of the glabella more pressed backward and more straight across, and in having three glabellar furrows in front of the neck furrow, instead of only two. The palpebral lobes of *franklini* are narrower than those of *tessini*, too.

The only seven specimens of this species known are small for examples of *Paradoxides*. The single known cranidium, which is small, may be that of a young individual.

The specific name is given in honor of the writer's son, who found the holotype.

LOCATION OF TYPES: The holotype is the cranidium. It is no. 9818a in the paleontological collection of Princeton University. The free cheeks and cheek spine are paratypes, nos. 9818b, 9819, 9877, 9983, and 40195 in the same collection, and the thoracic segment is also a paratype, no. 40188 in that collection.

A single free cheek has been found in the St. Albans formation, which may be that of a species of *Paradoxides* related to *Paradoxides forchhammeri*, of Scandinavia. It is too poorly preserved to make its generic reference certain; but it is tentatively assigned to *Paradoxides*, and described.

Paradoxides? pusulosus, new species

(Plate 4, figure 1)

Only the free cheek is known, and only the single, imperfect, example of it which is figured has been discovered. It has a long spine and is covered with tubercles, rather widely spaced. Its exact form cannot be determined, but it seems to have belonged to a trilobite that had a palpebral lobe of medium size.

OBSERVATIONS: The general shape of this cheek, the presence of tubercles on it, and the inferred size of the palpebral lobe of the trilobite to which it belonged, lead one

[23] Alex. Brongniart: *Histoire naturelle des crustacés fossiles* (1822) p. 31, 32, pl. 4, fig. 1. Paris.

to suspect that it may be the cheek of a species of *Paradoxides* closely related to *Paradoxides forchhammeri*. Until further evidence is discovered, however, even the generic reference of the species must be left in doubt. The width of the brim on the Vermont cheek is less than one would expect to find on the cheek of a *Paradoxides*, but only a part of the width of the brim appears to have been preserved in the specimen, so that this part of the cheek may well have been as wide as that of the average *Paradoxides*.

LOCATION OF TYPE: The holotype is no. 40200a in the paleontological collection of Princeton University. Its counterpart is 40200b in the same collection.

Next to the Agnostia the commonest trilobites in the St. Albans fauna are small species, most of which should probably be referred to the old families Solenopleuridae and Ptychoparidae and a new family, the Agraulidae.

The classification of these small trilobites, which are common members of the *Paradoxides* faunas of northwestern Europe and northeastern North America, is in a rather unsatisfactory condition, and needs revision. It is too large a task to undertake here, and the numerous species in the St. Albans fauna will consequently be classified, for the most part, as seems most in accordance with current practice, with the knowledge that future work on this group of trilobites may demonstrate that the species should be differently classified.

It is believed that several of the species are referable to the genus *Solenopleura;* but, as there exists some doubt concerning the true character and limits of this genus, it may be that time will prove that some of the species here included in it should have different generic names. The family Solenopleuridae is perhaps divisible into subfamilies; the genus, *Solenopleura,* as here used in its widest sense, is almost certainly divisible into two or more genera or subgenera; but this is not the place to attempt any such subdivisions, and the family and genus will, therefore, be defined here only in general terms, as an introduction to the description of the species.

Family SOLENOPLEURIDAE Angelin

Characterized by a somewhat tapering glabella, which shows more or less well developed glabellar furrows, small eyes, a brim that is thickened into an elevated ridge around its anterior edge, fixed cheeks whose rear corners are more or less extended sidewise, free cheeks with short genal spines, and a ribbed pygidium with few segments.

Three genera, *Solenopleura* Angelin, *Solenopleurella* Poulsen, and *Albansia,* a new genus, which are classified as in the family Solenopleuridae, are represented in the St. Albans fauna. They are defined and their Vermont species are described.

Genus *Solenopleura* Angelin

Has no well-developed neck spine. The body is larger, and the fixed cheeks are wider, than in *Albansia.* The test is smooth or tuberculate.

Solenopleura vermontensis, new species

(Plate 4, figures 2, 3, 6, 7)

CRANIDIUM: The dorsal, neck, and marginal furrows are deeply impressed, but the glabellar furrows, of which there are three, are only faintly indicated. The rear of these three glabellar furrows curves inward and backward, and extends clear to the neck furrow, and is more clearly defined than the other two, both of which run nearly straight inward from the dorsal furrows for a short distance, and both of which (and especially the anterior one) are so faint that they cannot be seen very clearly,

and many are quite invisible. There is no trace of a spine, or even a tubercle, on the neck ring. The glabella is large and wide (especially at the rear), and the fixed cheeks are correspondingly narrow. No trace of an eye-line is visible on any of the known specimens. The test was, as far as can be determined from the known examples, smooth. The other characters are well shown in the figures.

FREE CHEEKS: No well-preserved free cheek that appears to be certainly referable to this species has been found.

HYPOSTOME: A hypostome was found which may have belonged to a young individual of this species, for it lies near a young cranidium believed to be referable to *S. vermontensis*. It is long and narrow, with small lateral wings.

THORAX: A single thorax thought possibly to be referable to this species is known.

PYGIDIUM: The dorsal and transverse furrows are deeply impressed, and the axis and pleural lobes are rather highly convex, so that the entire shield has a rough and rugged appearance. The shield is also rather narrow for its length; and the axis is relatively wide, so that it and the entire pygidium have a stocky, nearly semicircular, form. The flange is highly convex and prominent.

OBSERVATIONS: The young cranidia differ from adult ones in having the glabella relatively narrower and the fixed cheeks relatively wider.

This species resembles *Solenopleura holometopa* Angelin of Scandinavia, but appears to differ from that species in its lack of tubercles and in minor details of its dimensions.

One species in the St. Albans fauna, *Solenopleura franklinensis*, somewhat resembles this one. It differs from the present species, however, in being smaller and less convex, in not having the fixed cheeks widely confluent in front of the glabella, in having the front of the glabella squarer (less pointedly rounded), and in having the brim thickened in front of the glabella. *Solenopleura vermontensis* is also a larger species than *S. franklinensis*.

LOCATION OF TYPES: The holotype is a cranidium, no. 9886 in the paleontological collection of Princeton University. Paratypes are nos. 9887-9897, 9915, 9916, 9942, 9954, 9955, 9967, 9976, 9979, 9986, and 41073 in the same collection.

Solenopleura franklinensis, new species

(Plate 4, figures 4, 5, 8-11, 14)

CRANIDIUM: The glabella is broadly truncated in front. Few specimens show any traces of transverse furrows, although the dorsal, neck, and marginal furrows are well developed. There is a short and blunt neck spine. There are eye-lines, but they are difficult to see, and are not visible on some specimens. The brim is thickened in front of the glabella, so that, when flattened, it projects backward nearly to the glabella. The fixed cheeks are only narrowly confluent in front of the glabella. The test appears to have been smooth. The other characters are shown in the illustrations.

FREE CHEEKS: The free cheeks which are believed to belong to this species are figured. They are short and wide, and are rather strongly convex. As no example of this species has been discovered with the free cheeks in place, the cheeks assigned to the species cannot now be proved to be referable to it.

HYPOSTOME: A single specimen, which may be a hypostome of this species, has been discovered. It is figured. It is not well preserved, and is identified with some doubt as to its true nature. It may be a cranidium of some other species of trilobite.

THORAX: The pleura have deep grooves and rounded ends. There are at least fourteen segments.

PYGIDIUM: The whole shield is rather highly convex. The dorsal furrow is strongly impressed, so that the axis stands out distinctly from the pleural lobes. The rear end of the axis is not segmented. The flange is narrow.

OBSERVATIONS: There is considerable variation in the details of form of the cranidia which are referred to this species, especially in the amount of thickening of the brim in front of the glabella. Also, the young cranidia differ from the adult ones in having the rear part of the glabella narrower.

There are several other trilobites in the St. Albans fauna that are difficult to distinguish from *Solenopleura franklinensis*. The present species can be recognized, however, by the truncated shape of the front of the glabella, which is cut almost straight across, instead of being rounded, so that the glabella has the appearance of a truncated pyramid.

As no entire examples of this species have been found, it has not been possible to be certain which of the several kinds of free cheeks and pygidia of small trilobites found in the St. Albans formation should be assigned to it. As the species is the commonest of the small trilobites in the formation, and as the commonest free cheeks and pygidia seemed to be of the sort which would accompany the cranidia on which the species is based, it is probable that they are here properly assigned.

The free cheeks of this species are characterized by their rather square shape and high convexity, as compared with the form and elevation of the other free cheeks of the same size that are found in the St. Albans formation.

LOCATION OF TYPES: The holotype is a cranidium, no. 9908 in the paleontological collection of Princeton University. Paratypes are nos. 9737, 9799, 9826, 9902-9908, 9914, 9917, 9927, 9931, 9934-9936, 9941, 9946-9953, 9956-9959, 9966, 9967, 9971, 9978, 9988, 40059, 40065, and 41115, in the same collection, and nos. 13404, 13421, 13423, 13425, and 13437 in the paleontological collection of the Peabody Museum of Natural History of Yale University.

Solenopleura spissa, new species

(Plate 4, figures 18, 21)

CRANIDIUM: Very similar to that of *Solenopleura franklinensis*, but larger, and having the glabella longer and narrower and the brim even more thickened in front and reaching all the way back to the glabella, so that the fixed cheeks are completely separated.

PYGIDIUM: A single pygidium, perhaps referable to this species, has seven segments in the axis and five ribs on the pleural lobes, with three rows of tubercles on the axis and one on the ribs. It may be referable to some other species, such as *Solenopleura tuberculata*.

OBSERVATIONS: Only the cranidium, and possibly the pygidium, of this species are known. The other parts of the test are presumably similar to those of *Solenopleura franklinensis* in form, but larger in size.

This species is so similar to *Solenopleura franklinensis* that it is perhaps impossible to tell young specimens from adult examples of that species. The two known adult cranidia of the present species are, however, twice as large as adult cranidia of *S. franklinensis;* this fact and the other small differences already mentioned appear to indicate that the two are distinct species.

LOCATION OF TYPES: The holotype is a cranidium, no. 9902 in the paleontological collection of Princeton University. The only other known specimens which seem to be referable to this species are a young and an adult cranidium, and a pygidium, paratype, nos. 9965, 9970, and 40233 in the same collection.

Solenopleura tuberculata, new species
(Plate 4, figures 13, 17)

CRANIDIUM: The whole shield is highly convex, like that of a typical *Solenopleura*, and is dotted with tubercles. The glabella is rather bluntly rounded in front, is highly convex, and shows three faint transverse furrows, which do not extend inward more than about a third of the way across the glabella from each side. The dorsal furrow is deep, and the fixed cheeks are convex. The neck furrow is also deeply impressed, as is the marginal furrow, and the brim is much thickened vertically around the front of the shield.

FREE CHEEK: A single free cheek, thought to belong to this species, was found. Its surface is tuberculate, like that of the cranidium.

PYGIDIUM: A pygidium that is thought to be probably referable to this species is preserved in the Princeton collection. It seems to be tuberculate. It is small and short. There are three segments on the axis; but no ribs are visible on the pleural lobes.

OBSERVATIONS: Only a few specimens of this species have been discovered. The species seems to be a typical *Solenopleura* of the tuberculate type, like *Solenopleura canaliculata*, of the *Paradoxides forchhammeri* zone of Scandinavia. It differs from that species in being smaller and in having a relatively larger glabella and narrower fixed cheeks.

LOCATION OF TYPES: The holotype is no. 9992 in the paleontological collection of Princeton University. The only other known examples are paratypes, nos. 9932, 9937, 9991, 9993, 9994, 40,001, 40,002, 40,121, 40,125, and 40,244 in the same collection.

Solenopleura pusilla, new species
(Plate 4, figure 12)

This species is based on the single tiny cranidium, which is figured.

The glabella is short and rather highly convex. It shows no transverse furrows. The brim is wide, but of low convexity. The fixed cheeks are of moderate convexity and width. They are about twice as wide at the rear as they are opposite the eyes, and they are widely confluent in front of the glabella. The surface of the test of the entire cranidium is thickly dotted with tiny pits.

OBSERVATIONS: It is possible that the cranidium on which this species is based is a young shield of some one of the other species of *Solenopleura* described in this paper; but this does not seem probable. It may, however, be a young cranidium, rather than an adult one, as it is small for a *Solenopleura*.

LOCATION OF TYPE: The holotype is no. 40,228 in the paleontological collection of Princeton University.

Solenopleura ? *latimargo*, new species
(Plate 4, figure 16)

CRANIDIUM: This species is known only from a single fragment of a cranidium. This cranidium somewhat resembles the cranidium of *Solenopleura spissa*, but has the front portion of the brim even more widened than is that of *spissa*, and yet has more space between the brim and the glabella than *spissa* has, so that the fixed cheeks are confluent in front. The convexity of *S.* ? *latimargo*, too, is greater than that of *S. spissa*, both the glabella and the fixed cheeks being rather highly arched.

OBSERVATIONS: This species may be referable to the genus *Solenopleura*, using that genus in its widest sense; but its reference to that genus will have to be a tentative one until more is known of the form of its entire cranidium than can be

learned from the single imperfect specimen now known. The writer does not know of any other species of *Solenopleura* that closely resembles it in form. *Armonia pelops* Walcott[23] has a cranidium that somewhat resembles that of *S.* ? *latimargo*. *A. pelops*, the only species of its genus that has been described, is, however, said to have lived in Late Cambrian times, and has been found only in Alabama; so it does not seem likely that *S.* ? *latimargo* will ever prove to belong in the genus *Armonia*.

LOCATION OF TYPE: The only known example of this species, the holotype, is no. 40,000 in the paleontological collection of Princeton University.

Genus *Solenopleurella* Poulsen

This genus was proposed by Christian Poulsen in 1927, to contain species of Solenopleuridae with a square glabella and a rim of practically even width.[24] The only species placed in the genus by Poulsen was *Solenopleurella ulrichi*, from the Middle Cambrian Cape Wood formation of Northwest Greenland. A single species, of the St. Albans fauna, to be described, appears to be referable to this genus, although all the known examples of it are so poorly preserved that the correctness of the generic reference is somewhat doubtful.

Solenopleurella rara, new species

(Plate 4, figure 25)

Only the cranidium is known, and only three specimens of it have been found, all of them incomplete. The shield is strongly convex, the glabella is nearly quadrate and has three transverse furrows that run only half way across, and the ocular fillet is well developed.

OBSERVATIONS: This species differs from *Solenopleurella ulrichi* in being wider in proportion to its length in all its parts.

LOCATION OF TYPES: The holotype is no. 41110 in the paleontological collection of Princeton University. Paratypes are nos. 40141 and 41111 in the same collection.

Genus *Albansia*, new genus

Very small. The glabella is more or less highly convex, and the cheeks are well arched, although the cranidium, as a whole, is not so much arched. The eyes are small. The fixed cheeks are not quite confluent, or are partly confluent, in front of the glabella. The brim is convex and somewhat thickened. The fixed cheeks are rather narrow, and are not greatly extended laterally at their rear corners. There is a visible ocular fillet, but it is faint.

The genotype is *A. pusilla*.

This genus is remarkable for its small size, its species being among the smallest of trilobites. The cranidium, which is the only part of the test definitely known, reminds one somewhat of that of a *Solenopleura*, or *Solenopleurella*, but the fixed cheeks are narrower, and the whole test is much smaller, than in that genus; the neck spine in some of the species also sets the genus off from both *Solenopleura* and *Solenopleurella*, and the lack of a strongly developed ocular fillet separates it from *Solenopleurella*.

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[23] C. D. Walcott: *Cambrian geology and paleontology*, vol. 5, no. 3, *Cambrian and Ozarkian trilobites*, Smithson. Misc. Coll., vol. 75, no. 3 (1925) p. 69, pl. 17, fig. 28-31.

[24] C. Poulsen: *The Cambrian, Ozarkian and Canadian faunas of Northwest Greenland*, Meddelelser om Grønland, vol. 70 (1927) p. 269.

It is possible, that the genus should be assigned to some other family than the Solenopleuridae. Its proper assignment must await the discovery of more certain information concerning the parts of its body other than the cranidium.

Albansia pusilla, new species

(Plate 4, figures 20, 23, 24)

CRANIDIUM: The glabella is highly convex and less tapering than that of *A. magna* (to be described). It is bluntly rounded in front. The fixed cheeks are much less convex than the glabella. They are confluent in front of the glabella by a narrow band. The brim is thickened and convex, but not wide. The rear corners of the fixed cheeks are more widely extended than those of *A. magna*. The entire shield, although convex in its parts, is only moderately arched as a whole. The eye is small. No ocular fillet is visible. The test is smooth. There is a large neck spine, which points directly backward and is not turned up.

FREE CHEEKS: Two free cheeks probably referable to this species have been discovered. Their form is similar to that of the next species, *Albansia obesa*.

PYGIDIUM: A single pygidium has been found which may be referable to this species. It is figured. Its axis is long, narrow, and well articulated, and it has strong ribs, with tubercles on them, on their pleural lobes. It may possibly be referable to one of the other species of *Albansia*, or even to *Solenopleura pusilla*.

OBSERVATIONS: This is a tiny species, if the only specimens which have been referred to it are really the remains of adult individuals. Only its cranidium is known. It is also a rare species, only a few examples having been discovered. They were all found in a sandy lens in the lower part of the St. Albans Shale.

LOCATION OF TYPES: The holotype is a cranidium, no. 40,117, in the paleontological collection of Princeton University. Paratypes are cranidia, nos. 40,119-40,121, 40,123, 40,124, 40,131, 40,132, 40,140, 40,158, 40,200, and 40,207, the free cheeks, 41,068 and 41,121, and the pygidium, 41,102, in the same collection.

Albansia magna, new species

(Plate 5, figures 1, 2)

CRANIDIUM: The shield is small. The glabella tapers to a bluntly rounded point in front. The cheeks are narrow and are confluent only by a narrow band in front.

PYGIDIUM: A single pygidium which may be referable to this species has been found. It is figured. It is poorly preserved, and, perhaps for this reason, shows no trace of segmentation of the axis or pleural lobes.

OBSERVATIONS: This is a rare species, only three cranidia and the one pygidium having been found. It is possible that the specimens on which the last species, which is described as *Albansia pusilla*, is based are really referable to this species, as the distortion of the cranidium of the present species makes it impossible to be certain of its exact form. The cranidia here described as those of *O. magna* are, however, larger than the cranidia on which the species, *A. pusilla*, is based (all of which are small and of about the same size), and their glabellas are more tapering, and the rear parts of their fixed cheeks are less extended, than those of the smaller cranidia; so that it seems probable that the two are different species.

LOCATION OF TYPES: The holotype cranidium is no. 40,115 in the paleontological collection of Princeton University. The paratype cranidia and pygidium are nos. 9940, 40,116, 40,195, and 40,221 in the same collection.

Albansia obesa, new species
(Plate 4, figures 19, 22, 23)

CRANIDIUM: This resembles the cranidium of *Albansia pusilla*, but is larger, and both the glabella and the whole shield are relatively wider for their length than they are in that species. The glabella is highly convex, and the whole shield is highly arched. There are three faint transverse furrows on the glabella. The rear one curves backward from the dorsal furrow. The other two run directly in for a short distance from the dorsal furrow.

FREE CHEEK: The brim is broad and convex. The rear part curves inward and ends in a blunt point.

OBSERVATIONS: This must have been a rare member of the St. Albans fauna, as only nine examples of it have been found.

LOCATION OF TYPES: The holotype is no. 40,146 in the paleontological collection of Princeton University. The other specimens are paratypes, nos. 9940, 40,123, 40,142, 40,158, 40,192, 40,200, 40,201, and 41,122, in the same collection, there being 2 cranidia on 40,158 and 2 cranidia and a free cheek on 40,192.

Albansia convexa, new species
(Plate 4, figures 26-28)

CRANIDIUM: The glabella is so convex as to be bulbous and almost hemispherical. It extends forward to the brim. The fixed cheeks are also convex, but not nearly so much so as the glabella. They are rather widely extended at their rear corners. The neck ring is narrow, and there is no neck spine or tubercle.

FREE CHEEKS: A single free cheek thought to be referable to this species has been found. It is narrow, with a wide, raised border, and a short, incurved spine. The palpebral portion is elevated and thickened.

PYGIDIUM: A single pygidium, which is probably referable to this (or less probably to one of the other species of *Albansia*) has been found. It is figured. It shows only the faintest traces of segmentation on the axis, but has five or six small ribs on the pleural lobes.

OBSERVATIONS: This species is remarkable for the great convexity of its glabella. It is rather a rare species in the St. Albans formation.

LOCATION OF TYPES: The holotype is no. 40,200b in the paleontological collection of Princeton University. Its counterpart is 40,200a, and paratypes are nos. 40,151, 40,159a, 40,175, 40,195, 40,213, 40,228, and 40,230-40,235 in the same collection.

PTYCHOPARIDAE and AGRAULIDAE

In 1888, G. F. Matthew suggested that certain small Cambrian trilobites should be grouped together in a family, which, because one of its genera was *Ptychoparia* Corda, he proposed to call the Ptychoparidae.[25] Matthew included in his new family the species which he called *Agraulos* (?) *whitfieldianus*, *A.* (?) *whitfieldianus compressa*, *Strenuella* (?) *halliana*, *Liostracus tener*, *L. onangondianus*, *L. onangondianus immarginata*, *L. onangondianus aurora*, *L. onangondianus gibba*, *L. onangondianus plana*, *Ptychoparia linnarssoni*, *P. linnarssoni alata*, *Solenopleura robbi*, *S. acadica*, and *S. acadica elongata*. All these species except *A.* (?) *whitfieldianus*, *A.* (?) *whitfieldianus compressa*, and *Strenuella* (?) *halliana*, he placed in a new subfamily, which he called the Ptychoparinae.

[25] G. F. Matthew: *Illustrations of the fauna of the St. John group*, no. IV, pt. II, *The smaller trilobites with eyes* (*Ptychoparidae and Ellipsocephalidae*), Roy. Soc. Canada, Tr., vol. 5, sec. 4 (1888) p. 123-166, pl. 1, 2.

The writer believes that the species which Matthew included in his new family and subfamily should be classified in at least four families, the Liostracidae, the Solenopleuridae, the Ptychoparidae, and the Agraulidae; that the species of Ptychoparidae and Agraulidae should be classified in four subfamilies, the Ptychoparinae, the Nassovinae, the Agraulinae, and the Micragraulinae—the Ptychoparinae and a new subfamily, the Nassovinae, being in the Ptychoparidae, and two subfamilies, the Agraulinae and the Micragraulinae, being in the Agraulidae. The species which Matthew placed in the genus *Liostracus* the writer believes to be properly assigned generically, but to belong to a different family from the others, the Liostracidae, which was proposed by Angelin many years ago.[26] The species which Matthew described as *"Agraulos ? whitfieldianus"*, together with its variety, *compressa*, the writer would place in a new genus, *Conagraulos*, in a new subfamily, Conagraulinae. Matthew's *"Strenuella ? halliana"* the writer places in a new genus, *Vermontella*, in the subfamily Nassovinae. The species which Matthew called *"Ptychoparia linnarssoni"* and its variety, *alata*, may perhaps be referable to *Ptychoparia*, but are possibly to be referred to some other genus of the Ptychoparidae. Matthew's species, *"Solenopleura robbi"*, the writer makes the genotype of a new genus, *Brunswickia*, of the subfamily Nassovinae, that has two species in the St. Albans fauna. The species called by Matthew *"Solenopleura acadica"*, and its variety, *elongata*, are perhaps referable to the family Solenopleuridae, but should, with *Solenopleura applanata* (Salter), of England, probably be placed, not in the genus *Solenopleura*, but in a new genus, although the evidence at hand is not conclusive on that point, and the final decision on that question must be postponed until more evidence is available.

The writer has found in the St. Albans fauna no species that appear to be referable to the Liostracidae. He has, however, found species that seem to him to belong possibly in the genera *Ptychoparia* (although he is in some doubt about this reference) and *Elrathia* Walcott,[27] and the new genus, *Conoides* (all of which genera perhaps belong in the Ptychoparinae), as well as the genera, *Brunswickia* and *Vermontella*, of the Nassovinae, and the new genera, *Micragraulos* and *Agrauloides*, of the Micragraulinae. The presence of these species in the St. Albans fauna has made it necessary to make a preliminary review of the trilobites which have usually been placed by authors in the genera *Ptychoparia*, *Solenopleura*, and *Agraulos*, so that some logical, even although not complete, classification of these species might be made, into which the Vermont species could be fitted. The following classification has been worked out, and is here used. One of the genera, *Nassovia*, that is included in this classification does not have representatives in the St. Albans Shale, as far as is known; but the others are all represented there by one or more species. All the species listed in the classification are of Middle Cambrian age, and all except *Elrathia kingi*, which is a Rocky Mountain form, are found in *Paradoxides* faunas in the North Atlantic region.

Family PTYCHOPARIDAE Matthew
Subfamily PTYCHOPARINAE Matthew[28]

Genus *Ptychoparia* Corda
Genotype, *P. striata* (Emmrich), of Bohemia

[26] N. P. Angelin: *Palaeontologia Scandinavica* (1878) p. 27.

[27] C. D. Walcott: *Cambrian geology and paleontology*, vol. 5, no. 2, *Cambrian and Lower Ozarkian Trilobites*, Smith. Misc. Coll., vol. 75, no. 2 (1924) p. 56.

[28] The genus *Amecephalus* Walcott is believed to belong in this subfamily, also.

Vermont species, *P. ? conveza,* new species
and *P. ? hispida,* new species
Genus *Elrathia* Walcott
Genotype, *E. kingi* (Meek), of the Rocky Mountains
Vermont species, *E. longa,* new species

Subfamily NASSOVINAE, new subfamily

Genus *Nassovia,* new genus
Genotype, *N. globiceps* (Grönwall), of Denmark
Also placed here, *N. globiceps jaculator* Howell, of Newfoundland
Genus *Brunswickia,* new genus
Genotype, *B. robbi* (Hartt), of New Brunswick
Also placed here, *B. quadrata,* new species of Vermont
Genus *Champlainia,* new genus
Genotype, *C. rectimargo,* new species, of Vermont
Genus *Vermontella,* new genus
Genotype, *V. clarae,* new species, of Vermont
Also placed here, *V. halliana* (Matthew), of New Brunswick

Family AGRAULIDAE, new family
Subfamily AGRAULINAE, new subfamily

Genus *Agraulos* Corda
Genotype, *A. ceticephalus* (Barrande)
Vermont species, *A. perkinsi,* new species
and *A. convexus,* new species
Also placed here, *A. quadrangularis* (Whitfield), of Massachusetts, and *A. affinis* Billings, of Newfoundland

Subfamily MICRAGRAULINAE, new subfamily

Genus *Micragraulos,* new genus
Genotype, *M. franklini,* new species, of Vermont
Other Vermont species, *M. decorus,* new species
Genus *Agrauloides,* new genus
Genotype, *A. socialis* (Billings), of Newfoundland
Vermont species, *A. vermontensis,* new species

Subfamily CONAGRAULINAE, new subfamily

Genus *Conagraulos,* new genus
Genotype, *E. rarus,* new species, of Vermont

No attempt is here made to classify the genus *Strenuella,* which Matthew included in the Ptychoparidae, and to which he doubtfully referred the species here called *Vermontella halliana.* Its genotype, *Strenuella strenua,* is found in the Lower Cambrian rocks of Newfoundland. Any effort to classify it should involve a discussion of other Early Cambrian trilobites; such a discussion would be out of place here.

The families, subfamilies, and genera of this classification are defined and discussed, in the order in which they are arranged in the classification, and the Vermont

species referred to them, all of which appear to be new, are described under their respective genera.

Family PTYCHOPARIDAE Matthew, emended

The glabella is narrow and relatively small, and is evenly rounded in front. It is usually smaller than in the Solenopleuridae. The brim is nearly flat, upturned, or convex; but is never highly convex or much thickened in front of the glabella, as it is in the Solenopleuridae. The fixed cheeks vary from narrow to rather wide; their rear ends are widely extended. The eyes are small. The dorsal furrow of the cranidium is moderately or deeply impressed. The whole cranidium is of low, medium, or high convexity.

Subfamily PTYCHOPARINAE Matthew, emended

The brim is almost flat or is convex. The glabella is narrow, but long, and is rather small and straight sided. The fixed cheeks vary from narrow to wide. The dorsal furrow of the cranidium is moderately or deeply impressed. The convexity of the whole cranidium is low, medium, or high.

This subfamily differs from the other subfamily of the Ptychoparidae, the Nassovinae, in having the glabella narrower and in other details of dimensions, which can easily be seen in the illustrations.

Genus *Ptychoparia* Corda

The convexity of the cranidium is rather high, and the dorsal furrow is deeply impressed. The ocular fillet is clearly developed. The whole cranidium has a deeply sculptured and rugged appearance. The pygidium is of low convexity, but the axis and pleural lobes are strongly segmented.

The genotype is ***Ptychoparia striata*** (Emmrich), of Bohemia.

Ptychoparia ? convexa, new species

(Plate 5, figures 3-6, 12)

CRANIDIUM: The glabella is narrow, but highly convex. There are two transverse furrows, and a faint trace of a third. They are directed diagonally backward at an angle of about 45 degrees, and extend only about half way across the glabella. The neck ring is well developed. It bears no spine in large adult cranidia, but in young cranidia has a long spine, which seems to have decreased in relative length as its owner increased in size. It is not always preserved, and may have been smaller on the cranidia of female individuals than on those of males. The ocular fillet is well developed. The eyes are small, but prominent. The brim is narrow, and is thickened at the front, where it is sharply upturned. The fixed cheeks are rather highly convex, reaching their greatest height, which is about the height of the glabella, just inside the eyes. The dorsal furrow is widely and deeply impressed beside the glabella, but is shallower in front of the glabella. The fixed cheeks are confluent in front of the glabella. The whole cranidium has a deeply indented contour, and the rear corners of the free cheeks are widely extended and are bent downward. The surface of the test is smooth. The shield, as a whole, is strongly arched.

HYPOSTOME: A poorly preserved hypostome was found which may be referable to this species. It may, however, belong to some other species than this, and its identification must remain in doubt.

FREE CHEEKS: The free cheeks believed to be referable to this species are flat, as compared with the cranidium, but with the portion that fits against the eye-lobe raised to fit that prominent part of the cranidium. There are rather long, sharp, genal spines. The surface of the cheek is smooth.

THORAX: A part of a thorax and a single pleuron which may be referable to this species were found. It is quite possible that they belong to some other species, however.

PYGIDIUM: The axis is narrow and long, reaching almost to the back edge of the shield. It has six segments, and there are five ribs on the pleural lobes. The convexity of the pleural lobes is low, but the axis rises well above the rest of the shield. The brim is narrow. The test is smooth.

OBSERVATIONS: This is one of the commonest of the small trilobites in the St. Albans fauna. It is remarkable for the fact that the majority of the specimens found are young cranidia.

This species is referred to the genus *Ptychoparia* with some doubt. It resembles *Ptychoparia striata* of Bohemia, the genotype of *Ptychoparia,* in many ways; but it is more convex in its form, and it lacks the striations that are present on the free cheeks and the front of the cranidium of that species. Until a comprehensive study of all the species that have the general characters of *P. striata* and *P. ? convexa* can be made, it seems best to refer the Vermont species to *Ptychoparia,* with the realization that it should perhaps have a new genus erected for its reception.

LOCATION OF TYPES: The holotype is a cranidium, no. 40,003 in the paleontological collection of Princeton University. Paratypes are nos. 9668, 9782, 9884, 9897, 9898, 9997, 40,004-40,027, 40,065, 40,128, 41,122 and 41,125 in the same collection, nos. 13,412, 13,427-13,431, and 13,437 in the paleontological collection of the Peabody Museum of Yale University, and no. 6461 in the paleontological collection of the Canadian National Museum. A paratype has also been deposited in the National Museum.

Ptychoparia ? hispida, new species

(Plate 5, figures 18, 19)

Only the cranidium and free cheeks are known. Only five examples of the cranidium and two free cheeks have been found. The cranidia are rather convex, with the fixed cheeks about as much elevated as the glabella, and with the brim thickened across the front of the shield, although it is not much thicker just in front of the glabella than it is away from the medial line. The fixed cheeks are rather widely confluent in front of the glabella. The glabella is small, nearly parallel sided, and is bluntly truncated in front. It shows clear rear transverse furrows, which run in and back part way to the medial line at an angle of about 45 degrees, and faint traces of two other, shorter, transverse furrows, which run inward more directly. The marginal and neck furrows are well developed, and the rear corners of the fixed cheeks are widely extended. The eyes are small. There is a small tubercle (not a spine) on the neck ring. The test of the whole shield is covered with little spined tubercles. The whole cranidium is gently arched. The two known free cheeks are fragmentary. They are striated, bear tubercles, and have a broad brim.

OBSERVATIONS: This species somewhat resembles *Solenopleura spissa* and *Ptychoparia ? convexa.* It differs from *S. spissa* in having a smaller and narrower glabella, less thickening of the brim in front of the glabella, the fixed cheeks less widely confluent in front, and the whole cranidium (except for the rear corners of the fixed cheeks) more quadrate in form. It differs from *P. ? convexa* in being covered with spined tubercles, in having the fixed cheeks narrower and the brim

less turned up in front, and in various other details of form. It is, however, so similar to *P. ? conveza* and to *Ptychoparia striata* that it is referred, although with some doubt, as in the case of *P. ? conveza*, to the genus *Ptychoparia*. Both *P. ? conveza* and *P. ? hispida* approach *Bolaspis* in form, but neither species appears to be actually referable to that genus.

LOCATION OF TYPES: The holotype is no. 40,054 in the paleontological collection of Princeton University. The five paratypes are nos. 5718, 40,159, 40,193, and 41,249 in the same collection. A paratype has also been deposited in the United States National Museum.

Genus *Elrathia* Walcott

The brim is almost flat. The fixed cheeks are narrow, except for their extended rear portions. The dorsal furrow of the cranidium is only moderately deep. The convexity of the whole cranidium is low, and the shield is only a little arched. The ocular fillet is usually visible, but is faint, at best. The whole cranidium has a flat look. The convexity of the pygidium, and especially of the pleural lobes, is low, and the segmentation of the axis and the pleural lobes is somewhat weaker than in *Ptychoparia*. There is no spine on the neck ring.

The genotype is *Elrathia kingi* (Meek), of the western United States.

Elrathia longa, new species

(Plate 5, figures 10, 11, 17, 22, 26)

CRANIDIUM: The characters are well shown in the illustrations, and need not be discussed here. They agree in all respects with those given for the genus *Elrathia*. The test of the whole shield is quite smooth.

FREE CHEEKS: As no cephalon of this species with the free cheeks attached to the cranidium has been discovered, it is not possible to state with certainty which of the types of free cheeks that occur in the St. Albans formation belongs to it. Examples of the type which is thought to be referable to this species are figured as probably such. The cheek that is Princeton no. 9907, especially, is believed to belong to this species. This type of free cheek is intermediate in form between the type assigned to *Solenopleura franklinensis*, which is narrow and compact in form, and the type assigned to *Champlainia rectimargo*, which is short and wide.

HYPOSTOME: Some of the hypostomes of small trilobites found may belong to this species. One of these is figured (Princeton no. 40,071).

THORAX: A few thoracic segments which are thought to be probably referable to this species have been found, some of which are figured. As no specimens of the cranidium of this species with part of the thorax attached have been found, it is not possible to be certain that the thoracic segments referred to *E. longa* are properly identified as belonging to it.

PYGIDIUM: A few pygidia believed to be referable to this species have been found. The best examples are illustrated. They are of low convexity, the pleural lobes being almost flat, although the axis rises somewhat above their level. The segmentation of the axis is rather poorly developed, but the ribbing of the pleural lobes is strong. There are four segments in the axis and three ribs on the pleural lobes.

OBSERVATIONS: This is one of the commoner species of small trilobites in the St. Albans fauna. It appears to belong in the genus *Elrathia*, as it shows many points of resemblance to *Elrathia kingi*. It differs from *E. kingi* in having the cranidium longer in proportion to its width, and in having the glabella relatively longer and the fixed cheeks narrower.

LOCATION OF SPECIMENS: The holotype is a cranidium, no. 40,055 in the paleontological collection of Princeton University. Paratypes are nos. 9907, 9708, 40056-40058, 40062-40070, 40073-40078, 40080-40082, 40090, 40100, and 41120 in the Princeton collection, and nos. 13423 and 13432-13437 in the paleontological collection of Yale University.

NASSOVINAE, new subfamily

The convexity of the cranidium is low or moderate. The brim is almost flat or moderately thickened. The fixed cheeks are narrow or moderately wide. The dorsal furrow of the cranidium is moderately developed. The fixed cheeks are confluent in front of the glabella, the distance from the front of the glabella to the brim being rather small or considerable. This area in front of the glabella slopes gently down to the brim. The cranidium is rather straight across the front, and the shield has a somewhat quadrate appearance, except that the rear corners of the fixed cheeks are more or less widely extended.

Nassovia, new genus

The distance from the front of the glabella to the brim is considerable. The brim is almost flat. The fixed cheeks are moderately wide. The convexity of the cranidium is moderate. The ocular fillet is strongly developed. The glabella is bluntly rounded in front.

The genotype is *Nassovia globiceps* (Grönwall), of Scandinavia.[29] *Nassovia globiceps jaculator* (Howell), of Newfoundland,[30] is also placed here.

This genus is not known to be represented in the St. Albans fauna. Its characterization is included here only to make complete the classification of the genera of the subfamily Nassovinae.

Brunswickia, new genus

The distance from the front of the glabella to the brim is small. The brim is of low convexity. The fixed cheeks are of moderate width. The convexity of the cranidium is moderate. The ocular fillet is not strongly developed. The glabella is subquadrate in form.

The genotype is *Conocephalites robbi* Hartt, of New Brunswick. One new Vermont species, *Brunswickia quadrata*, is also placed in this genus.

Brunswickia quadrata, new species

(Plate 5, figures 13, 32)

Only two cranidia are known. Their convexity is low, and their dorsal furrows are rather shallow. The brim is nearly flat. The glabella is short and wide and nearly parallel sided; it is almost straight across the front. The fixed cheeks are rather narrow, except where their rear parts extend laterally. The test is smooth.

OBSERVATIONS: In convexity and shape of the fixed cheeks and brim the two cranidia on which this species is based resemble cranidia of *Elrathia longa*, and it is possible that they may be distorted cranidia of that species. Their glabellas are, however, much shorter than the glabella of an *Elrathia longa*, and are square across the front. The whole shield resembles that of *Brunswickia robbi* so much that the two would seem to belong in a single genus.

[29] K. A. Grönwall: *op. cit.*, p. 145, 146, pl. 4, fig. 12a, b.

[30] B. F. Howell: *The faunas of the Cambrian Paradoxides beds at Manuels, Newfoundland*, Bull. Am. Paleont., vol. 11, no. 43 (1925) p. 91-93, pl. 3, fig. 14.

It is possible that the discovery of additional evidence in the future will show that the species which is here called *Elrathia longa* actually belongs in the genus *Brunswickia,* rather than in the genus *Elrathia.*

LOCATION OF TYPES: The holotype is no. 40,092 in the paleontological collection of Princeton University. The two paratypes are nos. 5769 and 40,067 in the same collection.

Genus *Champlainia,* new genus

The distance between the front of the glabella and the brim is short. The brim is convex, not flat, and is thickened. The fixed cheeks are rather narrow. The glabella is evenly rounded in front. The convexity of the whole shield is medium, and the glabella rises above the level of the fixed cheeks. The ocular fillet is poorly developed.

The genotype is *Champlainia rectimargo,* new species, of Vermont.

Champlainia rectimargo, new species

(Plate 5, figures 7-9, 31, 34; Plate 6, figure 8)

CRANIDIUM: The characteristics of the cranidium are those given for the genus *Champlainia.* The front of the shield is straight. The test appears to have been nearly or quite smooth.

FREE CHEEKS: Four free cheeks which seem referable to this species have been found. Two of them are figured. They are characterized by being shorter and wider than the other free cheeks found in the St. Albans Shale.

PYGIDIUM: A single pygidium was found which is thought to be probably referable to this species. It has three poorly developed ribs on the pleural lobes. The axis is not preserved, so the number of segments which it had cannot be determined.

OBSERVATION: Only a few cranidia which seem referable to *Champlainia rectimargo* have been discovered, and some of these are referred to that species with hesitation, as they are distorted so that their form and dimensions are not definitely determinable.

LOCATION OF TYPES: The holotype is a cranidium, no. 40,093 in the paleontological collection of Princeton University. Paratypes are nos. 40,024, 40,094-40,100, and 41,067 in the same collection, and nos. 13,433 and 13,438 in the paleontological collection of the Peabody Museum of Yale University.

Genus *Vermontella,* new genus

The glabella is long and tapering and is evenly rounded in front. The fixed cheeks are narrow, and the whole shield has a long, narrow, tapering appearance. The rear corners of the fixed cheeks are not extended as widely as in the other species of the Nassovinae. The ocular fillet is poorly developed or absent. The brim is only slightly convex and is tilted upward in front. The glabella is rather highly convex, but the fixed cheeks, although convex, are less highly so. The whole shield is convex in its parts for a genus of the Nassovinae, but is not so highly arched, as a whole, as are the shields of some of the other genera.

The genotype is *Vermontella clarae,* new species, of Vermont. The New Brunswick species described by G. F. Matthew as *Strenuella* (?) *halliana*[21] is also believed to belong in this genus.

Vermontella clarae, new species

(Plate 5, figures 27, 33)

CRANIDIUM: The glabella shows no traces of transverse furrows. The test is smooth. The ocular fillet is poorly preserved, and cannot be seen on most specimens.

[21] G. F. Matthew: *op. cit.,* p. 132, 133, pl. 1, fig. 2a-m.

FREE CHEEK: Two free cheeks that appear to fit the cranidium of this species have been found. Their characters are as well shown in the figures of it which are presented in this paper as the preservation of the cheeks makes it possible to see them.

OBSERVATIONS: This species differs from *V. halliana* (Matthew) in lacking transverse furrows on the glabella and in minor details of the dimensions of its parts. The specific name is given in honor of Mrs. Howell.

LOCATION OF SPECIMENS: The holotype is a cranidium, no. 40,105a in the paleontological collection of Princeton University. Paratypes are nos. 40,105b, 40,105c, and 40,106-40,110 in the same collection. A single fragmentary cranidium, larger than any of the others referred to this species, no. 5771 in the Princeton collection, may be this species, or may be another species of this genus. Its poor preservation prevents its being more accurately identified.

Family AGRAULIDAE, new family

The glabella is almost or quite flush with the fixed cheeks in convexity, although the whole cranidium is gently arched or rises well above the general level of the shield. The portion of the cranidium in front of the glabella may slope downward to the front edge of the shield, the brim, where one is present, having the same downward slope as the rest of the shield; or the front of the brim may be upturned and thickened. The fixed cheeks are not extended laterally at their rear corners, but are bluntly triangular. The eyes and the pygidium are small.

This family contains two subfamilies, the Agraulinae and the Micragraulinae, which are described. Its species were included by Matthew in the Ptychoparidae, as already noted.

Subfamily AGRAULINAE, new subfamily

The glabella is almost or quite flush with the fixed cheeks in convexity. There is no brim, the portion of the cranidium in front of the glabella sloping evenly down to the front of the shield.

Only the single genus, *Agraulos,* is assigned to this subfamily.

Genus *Agraulos* Corda

The features that characterize the subfamily Agraulinae characterize this genus.

The genus *Agraulos* was proposed by Corda[82] in 1847. *Agraulos ceticephalus* (Barrande), of Bohemia, appears to be the genotype. *Agraulos affinis* Billings, of Newfoundland, *Agraulos quadrangularis* (Whitfield), of Massachusetts, and other similar species belong here. A few examples of two new species have been found in Vermont, which appear to be referable to this genus also. They are described as *Agraulos perkinsi* and *Agraulos convexus.* The specific name of the first-mentioned species is given in honor of G. H. Perkins, who for so many years and with such great distinction served Vermont as its State Geologist.

Agraulos perkinsi, new species

(Plate 5, figure 14)

Only the cranidium is known. Only two specimens which appear to be referable to the species have been found. Neither of these is complete, the rear part of the

[82] Ignaz Hawle and A. J. C. Corda: *Prodrom einer Monographie der bömischen Trilobiten* (1847) p. 26, 27. Prague.

shield being missing from both of them. One appears to be an exfoliated specimen. The dorsal furrow is deeper in the unexfoliated specimen than in the exfoliated one. The glabella is visible, but is only slightly raised above the general level of the shield; and the dorsal furrow is weak. No transverse furrows can be seen. The test is smooth. There is a large, straight, spine on one of the paratypes (a very small specimen), and, although the rear part of the cranidium is not preserved in the other two specimens, there is an indication of the base of a spine on the holotype shield.

OBSERVATIONS: The holotype and the single paratypes are on a piece of limestone, which was collected by G. E. Edson, and which was probably from a pebble in the Mill River Conglomerate. Examples of several typical St. Albans species occur on the same piece of rock. Therefore, although the rock was probably not found in the St. Albans formation, the species would seem to have been a member of the St. Albans fauna, and is consequently described here as such.

LOCATION OF TYPES: The holotype is no. 9997a in the paleontological collection of Princeton University. The single paratype is no. 9997b.

Agraulos convexus, new species

(Plate 5, figure 15)

Only the cranidium is known, and only five examples of it have been found. These are small and highly arched. The glabella is scarcely distinguishable, there being only the faintest trace of a dorsal furrow, and the glabella being uniform in convexity with the rest of the shield. A large neck spine extends straight back from the glabella. The glabella reaches far forward, but the fixed cheeks are confluent in front of it. The brim is not set off by a marginal furrow, and is only indicated by a thickening and slight convexity of the front border of the shield. The test is smooth.

OBSERVATIONS: This species is more convex than the average *Agraulos*, and has a larger neck spine. It perhaps deserves a genus of its own; but it seems best to place it in *Agraulos* until more is learned about it and any closely related species that may exist.

LOCATION OF TYPES: The holotype is no. 40,126 in the paleontological collection of Princeton University. The four paratypes are nos. 40,122, 40,200 (two examples), and 40,203 in the same collection.

Subfamily MICRAGRAULINAE, new subfamily

The glabella is a little elevated or considerably elevated above the general convexity of the shield. There is a turned up and thickened brim.

Three genera, all new, and all found in Vermont, are assigned to this new subfamily. They are described below as *Micragraulos*, *Agrauloides*, and *Conagraulos*.

Genus *Micragraulos*, new genus

The brim is strongly turned up and thickened in front of the glabella. The glabella is relatively large, and reaches forward so far that the fixed cheeks are not widely confluent in front of it. The whole shield is evenly and moderately convex.

The genotype is the new species, *Micragraulos franklini*, which is described. A second new species in the St. Albans fauna is also described below as *Agraulos decorus*.

Micragraulos franklini, new species
(Plate 5, figures 16, 20, 21, 25)

CRANIDIUM: The shield is wider in proportion to its length than in *Micragraulos decorus*. The glabellas of adult cranidia, especially, are relatively wide. The glabella approaches so close to the brim that the fixed cheeks are narrowly confluent in front of it. The test is smooth. There is a large neck spine, which is pointed diagonally upward.

FREE CHEEKS: These are crescent shaped, and have a wide and convex brim. Their spines are short. They are not so narrow as the free cheeks of *Micragraulos decorus*. The test is smooth.

PYGIDIUM: The axis is convex—more so than it is in the pygidium which is assigned to *Micragraulos decorus*. There are four segments in the axis and four ribs on the pleural lobes, but the last segment and last rib are faintly defined. The test is smooth.

OBSERVATIONS: This species is distinguished from *Micragraulos decorus*, with which it is associated, by its shorter cranidium, the less space between its glabella and its brim, and the fact that its neck spine points diagonally upward, instead of straight backward. It also seems to have attained a somewhat greater size than *M. decorus*. Young specimens appear to have had relatively narrower glabellas than adult ones.

LOCATION OF TYPES: The holotype is no. 40,135 in the paleontological collection of Princeton University. Paratypes are nos. 9912, 9940, 40,103, 40,124, 40,136-40,140, 40,143-40,152, 40,159a, 40,160, 40,197, 40,198, 40,200, and 41,118 in the same collection.

A fragmentary fossil, found in the St. Albans formation, may possibly be a deformed specimen of *Micragraulos franklini*, although it is too incomplete to permit a definite determination of its nature. Its peculiarity lies in the remarkable heavy, blunt, curved spine which it bears, and which is perhaps an abnormal neck spine on an individual of this species. The specimen is no. 40,233a in the paleontological collection of Princeton University.

Micragraulos decorus, new species
(Plate 5, figures 23, 24, 28-30)

CRANIDIUM: The shield is more elongate in shape than that of *Micragraulos franklini*. The glabella, although more elongate than that of *M. franklini*, does not reach so near to the brim as it does in that species, except in young individuals. The rear portions of the fixed cheeks are narrower than they are in *M. franklini*. The test is smooth. There is a long neck spine, which points straight backward.

FREE CHEEKS: These are narrower than those of *M. franklini*, although similar in other respects. The test is smooth.

PYGIDIUM: The axis is not quite so convex as in *M. franklini*. There are only three segments distinguishable on the axis, and only the first of these is well developed. Only two ribs can be seen on the pleural lobes, and both of these are faint.

OBSERVATIONS: This species, like *M. franklini*, is a rather rare member of the St. Albans fauna. As no entire specimens of either species have been found, it is not possible to be certain which free cheeks, and especially which pygidia, should be assigned to the two species. It is possible that they are wrongly assigned here.

LOCATION OF TYPES: The holotype is no. 40,153 in the paleontological collection of Princeton University. Paratypes are nos. 40,126, 40,154, 40,157, 40,158, 40,160-40,170, 40,191, 40,200, 41,106, and 41,117 in the same collection, and nos. 13,440 and 13,441 in the paleontological collection of the Peabody Museum of Yale University.

A single new species, which occurs rarely in the St. Albans fauna, appears to belong in the subfamily, Micragraulinae, but to need a new genus for its reception. This genus is characterized, and the species is described.

Genus *Agrauloides*, new genus

The brim is greatly thickened across the entire front of the cranidium. The glabella is relatively small, and is not so long as it is in *Micragraulos*, so that the fixed cheeks are widely confluent in front of it. The convexity of the whole shield is rather low.

The genotype is *Agraulos socialis* Billings, of Newfoundland. A single new species believed to be referable to the genus has been found in the St. Albans fauna. It is described as *Agraulos vermontensis*.

Agrauloides vermontensis, new species

(Plate 6, figures 1, 9)

CRANIDIUM: The fixed cheeks are rather narrow. The space between the front of the glabella and the brim is not great. The glabella stands distinctly above the level of the fixed cheeks. There is no neck spine, at least in adult cranidia. There are faint traces of two glabellar furrows. The test is smooth.

FREE CHEEKS: There is a small genal spine. The convexity of the cheeks is low. Their shape is shown in the illustrations.

THORAX: All that is known about the thorax is visible in the figure of the holotype which is presented.

OBSERVATIONS: This species differs from *Agrauloides socialis* in having the fixed cheeks narrower, the brim more thickened, less space between the front of the glabella and the brim, and no neck furrow, and in other details of form. It is a rare species in the St. Albans formation, only three examples having been discovered.

LOCATION OF TYPES: The holotype is no. 40,171 in the paleontological collection of Princeton University. The only other known examples are two paratypes, nos. 40,172 and 40,173 in the same collection.

Subfamily CONAGRAULINAE, new subfamily

The characters of this subfamily are those of its only known genus, *Conagraulos*, which is defined.

Genus *Conagraulos*, new genus

The glabella is well elevated above the fixed cheeks, which are low. The brim is flat. There is a large neck spine, which points upward and backward at an angle of about 45 degrees.

The genotype is *Conagraulos rarus*, to be described. Matthew's *"Agraulos (?) whitfieldianus,"* of New Brunswick, is also believed to belong in this genus.

It is possible that this genus should be classified in some other family than the Agraulidae, perhaps in a new family of its own. Until more is known of the family and of the entire test of some species of *Conagraulos*, however, it seems best to place the genus in the Agraulidae.

Conagraulos rarus, new species

(Plate 6, figures 3, 10, 18)

CRANIDIUM: The glabella is nearly straight sided and is rather quadrate in front. The fixed cheeks are low, and the brim is flat. The glabella is long, reaching almost to the brim. The rear corners of the fixed cheeks are flattened and expanded.

FREE CHEEKS: A free cheek which is thought to be possibly referable to this species is figured, and all that is known of it is shown in the illustration.

PYGIDIUM: A single pygidium which may be referable to this species is figured. It shows four segments in the axis and pleural lobes, and is short and wide.

OBSERVATIONS: This is a rare member of the St. Albans fauna, only seven examples having been found. It differs from *Conagraulos whitfieldianus* in its longer and more bluntly terminated glabella, in the expansion of the rear corners of its fixed cheeks, and in other details of form and dimensions.

LOCATION OF TYPES: The holotype is no. 40,174 in the paleontological collection of Princeton University. The other known specimens are paratypes, 9940, 40,140, 40,159a, 40,175-40,177, 40,200, 40,214, and 40,129 in the same collection.

There have been found in the St. Albans Shale a few cranidia which appear to be referable to the family Corynexochidae Angelin, the subfamily Dolichometopinae Walcott, and the genus *Dolichometopus* Angelin. Their family, subfamily, and genus are characterized, and the new species *Dolichometopus vermontensis*, to which the specimens are believed to belong, is described. As C. D. Walcott defined the family Corynexochidae in 1916, his definition is copied here. Angelin gave no definition of the genus, but merely named it and referred his genus, *Corynexochus*, to it.

Family CORYNEXOCHIDAE Angelin

"Opisthoparia with cephalon and pygidium subequal in size or with pygidium smaller than the cephalon. Glabella usually expanded anteriorly and with only narrow limb and border in front. Eyes of medium to large size, with strong palpebral lobe and with palpebral (ocular) ridge crossing fixed cheeks. Thorax with 7 to 11 segments; pleural furrows broad and usually straight. Pygidium more or less strongly ribbed. Surface of test apparently punctate and with irregular, inosculating, fine, sharp ridges which may be smooth or broken up into granulated ridges."[83]

Subfamily DOLICHOMETOPINAE Walcott

Walcott did not define this subfamily. He placed in it the genera *Bathyuriscus* and *Dolichometopus*, together with *Housia*, a subgenus of *Dolichometopus*. These genera are characterized by the possession of less pear-shaped glabellas than those of the genus *Corynexochus* (the other genus of the family Corynexochidae, for which P. E. Raymond in 1928 proposed that the subfamily Corynexochinae be established, with the characters of its type genus), and more sharply pointed distal ends on their pleura. The pygidia of the Dolichometopinae have wide flanges; those of the Corynexochinae are narrow. Most of the Corynexochinae have one or more small spines on the flange near the front corners of the pygidium (Walcott states that these spines are characteristic of the genus *Corynexochus*, though no spines are visible on some of the pygidia of that genus which he figures), but such spines are not known to be present on the pygidia of any species of the Dolichometopinae.

Genus *Dolichometopus* Angelin

Walcott has given a full definition of this genus. The essential portions of this definition are repeated:

"Cephalon semicircular with postero-lateral angles prolonged in sharp spines; cranidium large, with strong fixed cheeks, long postero-lateral limbs and inconspicuous antero-lateral limbs; glabella more or less broadened anteriorly and slightly

[83] C. D. Walcott: *Cambrian geology and paleontology*, vol. 3, no. 5, *Cambrian trilobites*, Smithson. Misc. Coll., vol. 64, no. 5 (1916) p. 308-311.

contracted midway; frontal limb narrow, slightly rounded or flattened and with a furrow of varying size and depth between it and the glabella; occipital ring broad and defined from the glabella by a shallow, gently concave furrow; free cheeks of medium size and terminating in a strong spine at the genal angle. The facial sutures cut the posterior border of the cephalon at about the genal angles and then extend inward and forward to the base of the narrow eye lobes near which they curve; in front of the eyes the sutures extend forward with a gentle outward and then inward curve so as to cut the front margin on a line with the sides of the front portion of the glabella. Thorax with seven segments; pleural lobes with each segment having a distinct furrow crossing from the inner interior side to the posterior outer side; the anterior outer half of each segment has a sloping faceted surface and the segments terminate in a more or less sharp falcate end. Pygidium large with the anterior margin arched slightly forward; axial lobe convex with from five to seven transverse segments and a terminal section; pleural lobes with a broad margin and more or less faintly marked by shallow, narrow furrows that serve to indicate the outward extension of the anchylosed segments of the axial lobe."[24]

The genotype is *Dolichometopus suecicus* Angelin, of Scandinavia.

The genus is known only from Middle Cambrian rocks, but has been found in Scandinavia, southeastern Canada, the southeastern United States, Arizona, Utah, Idaho, and the Canadian Rockies, and is now recorded from Vermont.

Dolichometopus vermontensis, new species

(Plate 6, figures 2, 7)

Only the cranidium and free cheeks are known.

CRANIDIUM: The glabella is rather short and only slightly expanded in its anterior third. Faint indications of two transverse furrows can be seen indenting its sides. The fixed cheeks are large and wide. The eyes are small. The fixed cheeks are confluent in front of the glabella, although this feature cannot be seen in specimens in which the glabella has been flattened or pushed forward by pressure.

FREE CHEEKS: Two free cheeks which appear to be referable to this species have been found. Their shape can be seen in the figures of them which are presented.

OBSERVATIONS: This species has larger fixed cheeks than any other known species of *Dolichometopus*. It appears to resemble *Dolichometopus suecicus* more than any other species of the genus; but it differs from that species in having larger fixed cheeks, shorter eyes, and a shorter glabella.

LOCATION OF TYPES: The holotype is a cranidium, no. 40,223 in the paleontological museum of Princeton University. Paratypes are nos. 9717, 40,065, 40,070, 40,168, 40,224, 40,225, 40,229, and 40,236 in that collection, and 13,437 in the paleontological collection of the Peabody Museum of Yale University.

There have been found in the St. Albans Shale a few free cheeks, thoracic segments, and pygidia, and a single imperfectly preserved cranidium, which appear to be referable to species of *Anomocare*, a genus that is common in the *Paradoxides forchhammeri* zone of Scandinavia and occurs also in beds of the same general age elsewhere in the world. No well-preserved *Anomocare* cranidia have been found in the St. Albans Shale. Nevertheless, it seems probable that some of the Vermont fossils are referable to that genus, and they are, therefore, so described.

The genus *Anomocare* was defined by Angelin and was assigned by that author to the family Liostracidae. It is believed not to belong in that family, however. A new family, Anomocaridae, was proposed for it and for *Glyphaspis* by Christian Poulsen in 1927.[25] The writer would place *Anomocarella* Walcott in this family also.

[24] C. D. Walcott: *op. cit.*, p. 356, 357.

[25] C. Poulsen: *The Cambrian, Ozarkian, and Canadian faunas of Northwest Greenland*, Meddelelser om Grønland, vol. 70 (1927) p. 325.

Family ANOMOCARIDAE Poulsen

Trilobites with wide cephala and pygidia of approximately equal size, long, semicircular palpebral lobes, gently tapering glabellas of moderate length, wide free cheeks with short genal spines and a rather wide and flat border on the cranidium in front of the glabella, a narrow, tapering axis, ribbed pleural lobes, a wide, flat outer border on the pygidium, and from ten to twelve thoracic segments.

This family includes the genera, *Anomocare Angelin, Anomocarella* Walcott, and *Glyphaspis* Poulsen, and its members lived in Medial Cambrian times.

Genus *Anomocare* Angelin

The palpebral lobes are almost as long as the glabella. The glabella bears several transverse furrows, which do not extend all the way across it. The portion of the cranidium in front of the glabella is relatively wide.

The genotype is *Anomocare laeve* Angelin, of Scandinavia.

The genus lived in Medial Cambrian days, and appears to have been most abundant in late Medial Cambrian times.

Anomocare vermontense, new species

(Plate 6, figures 4, 5, 19)

Only the free cheeks and pygidium and a pleuron are known.

FREE CHEEKS: All that is known of the free cheeks believed to belong to this species is shown in the illustrations of the two cheeks of this type which have been found.

THORAX: The single fragmentary pleuron which is figured is perhaps referable to this species. It has a deep pleural groove.

PYGIDIUM: The axis is long and tapering, with five segments. There are six ribs on the pleural lobes. These ribs are well developed on the main part of the pleural lobes, but are faintly developed where they cross the wide flattened outer portion of the shield.

OBSERVATIONS: This species appears to have the axis of the pygidium a little longer than is usual in the genus. It is also large in size for an *Anomocare*.

LOCATION OF TYPES: The holotype is a pygidium in a limestone pebble from the St. Albans formation, collected by Edson, presumably from the Mill River Conglomerate. It is no. 40,206 in the paleontological collection of Princeton University. Paratypes from the St. Albans formation are nos. 40,159b, 40,195, 40,207, 40,208, 40,212, and 40,222b in that collection and no. 13,426 in the Peabody Museum of Yale University.

Anomocare dubium, new species

(Plate 6, figure 27)

Two fragmentary free cheeks, four fragmentary pygidia, and three pleura found in the St. Albans formation may belong to a species of *Anomocare*. They are here referred to that genus and assigned to a new species.

FREE CHEEKS: All that is known of the form of the free cheeks can be seen in the figure which is presented.

PLEURA: The pleura have well-developed grooves. They are rather long and narrow, slightly tapering, and appear to have had pointed distal ends.

PYGIDIUM: The axis is segmented, and there are ribs on the pleural lobes. The rear part of the shield seems to have been smooth, and is turned up.

OBSERVATIONS: These specimens are so different in size from the others which appear to be referable to *Anomocare* (being considerably larger than those assigned

to *Anomocare pusillum* and smaller than those belonging to *A. vermontense*) that it seems necessary to refer them to a separate species. Little can be determined about them, however, from the material at hand; and they may well not all belong to a single species.

LOCATION OF TYPES: The holotype is a free cheek, no. 40,074a in the paleontological collection of Princeton University. The other specimens are paratypes nos. 9820a and 40,074b, 40,217-40,220, 41091 and 41092 in the same collection.

Anomocare ? *rex*, new species

(Plate 6, figure 23)

A few pleurs and fragments of what appear to be pygidia have been found in the St. Albans Shale, which seem to be referable to a large species of *Anomocare*, although it is not possible to be certain about their classification, and they may not all belong to a single species.

The holotype pleuron is long and narrow, nearly straight, and with a deep pleural groove. It bends backward just a little at the distal end. A second pleuron, of which only the distal end is preserved, is also straight (what there is preserved of it) and bends backward a little at the distal end, where it is sharply pointed. A third pleuron appears to have been curved. It may have belonged to a different species.

The two fragments that look like parts of pygidia are too incomplete to throw any light on the form of the shields from which they came. Both seem to be parts of the pleural lobes, and both show strongly developed ribs.

LOCATION OF TYPES: The holotype pleuron is no. 40,209 in the paleontological collection of Princeton University. The paratypes are nos. 40,073, 40,210, and 40,211 in that collection, and no. 13,439 in the Peabody Museum of Yale University.

Genus *Anomocarella* Walcott

This genus was erected by C. D. Walcott in 1905, to hold certain species from the Middle Cambrian rocks of China, which lacked glabellar furrows and had a relatively narrow, flattened, frontal rim. Several species of this genus were figured by Walcott in 1913. A single fragment of a free cheek found in the St. Albans formation so much resembles the corresponding portion of the free cheek of *Anomocarella butes*, from the Kuilung group, of Shan-tung, figured by Walcott that it seems probable that it is referable to the same genus. It is, therefore, described as a new species, referred tentatively to *Anomocarella*.

Anomocarella ? *convexa*, new species

(Plate 6, figure 12)

Only the free cheek is known, and merely a part of that. The shape of this fragment is shown in the figure. The brim is wide and flat, but the rest of the cheek rises steeply and evenly to the suture edge, being most convex at the edge that lay against the palpebral lobe.

OBSERVATIONS: This species differed from *Anomocarella butes* in having a shorter palpebral lobe, and doubtless in other ways.

LOCATION OF TYPE: The holotype is no. 41125 in the paleontological collection of Princeton University.

There have been found in the St. Albans formation, and in limestone pebbles from that formation enclosed in the matrix of the Mill River Conglomerate, cranidia, free cheeks, a hypostome, fragments of the thorax, and pygidia, which are perhaps referable to a single species that appears to belong in the subfamily Ogygiocarinae Raymond of the family Asaphidae Burmeister. These specimens are here assigned

to a new species, which is made the genotype of a new genus, and which is described as *Conoides edsoni*. This new genus appears to be closely related to the genus, *Asaphiscus* Meek, which Walcott has placed in the Ogygiocarinae.

The family Asaphidae and subfamily Ogygiocarinae are defined, and the new species is described.

Family ASAPHIDAE Burmeister

Cephalon and pygidium of about the same size and shape. A medium-vertical suture in the doublure of the cephalon. Eyes prominent, but not long. Glabella medium in length or of more than medium length, and, where long, expanded in many specimens toward the front end. From seven to eleven or more segments in the thorax. Pygidium with or without segmentation.

Subfamily OGYGIOCARINAE Raymond

The palpebral ridge crosses the free cheeks. The hypostome is rounded or pointed behind.

Genus *Conoides*, new genus

The distance between the front of the glabella and the brim is small. The brim is almost flat. The fixed cheeks are rather narrow. The glabella is large and shaped like a truncated cone. The ocular fillet is visible, but is not strongly developed. The convexity of the whole cranidium is high, and the shield is strongly arched. The fixed cheeks are highly elevated and extended in the portion where the palpebral lobe is.

The genotype is *Conoides edsoni*, new species, of Vermont.

If the pygidium assigned to this genus really belongs there, the genus appears to be closely related to *Asaphiscus* Meek. *Conoides* differs from *Asaphiscus* in that its glabella extends forward nearly to the brim, whereas in *Asaphiscus* there is a wide space between the two. If the thorax found in the St. Albans Shale and assigned to the genus belongs to it, there is a difference in the number of thoracic segments also, as *Asaphiscus* is said to have from seven to eleven thoracic segments, and the thorax assigned to *Conoides* had at least fourteen segments.

Conoides edsoni, new species

(Plate 6, figures 6, 13, 20, 21)

CRANIDIUM: Most of the characters of the cranidium of this species are given in the characterization of the genus. All that need be said about the shield here is that its test is smooth.

FREE CHEEKS: The free cheeks which are believed to be referable to this species are broad and rather convex, with a wide border and a long, narrow, spine.

HYPOSTOME: A single hypostome thought to be referable to this species has been found in what was probably a pebble of the St. Albans formation, which was collected by Edson, presumably from the Mill River Conglomerate. It is highly convex, with straight and nearly parallel sides and with the anterior only a little wider than the rest.

THORAX: Has at least fourteen segments. Axis of medium width. Pleura long and narrow, with sharply pointed ends. Pleural grooves shallow near the axis, but deeper toward the extremities.

PYGIDIUM: The axis and pleural lobes are only faintly segmented, and the convexity of the axis is low.

OBSERVATIONS: This is a rare species in the St. Albans formation, but it occurs commonly, in association with other species, in pieces of limestone which were collected years ago by the late G. E. Edson, of St. Albans, either from the Mill River Conglomerate (where they must have been present as pebbles) or, less probably, from limestone lenses in the St. Albans Shale. These specimens collected by Edson, together with others collected by the writer from St. Albans pebbles in the Mill River Conglomerate, will be described in a later paper.

The species is named in honor of Edson.

LOCATION OF TYPES: The holotype, which is preserved in shale, is no. 9990 in the paleontological collection of Princeton University. Other specimens, paratypes, found in the St. Albans Shale are nos. 9943, 9991, 9999, 40,060, 40,070, 40,103, 40,104, 40,140, 40,155, 40,159, 40,175, 40,176, 40,184, 40,185, 40,189, 40,190, 40,191, 40,245, 41,092b, and 40,228b in the same collection; and two paratype specimens collected by Edson from limestone, probably a pebble in the Mill River Conglomerate, are no. 9998 in that collection also. Two specimens from the St. Albans Shale are paratypes, nos. 13,433 and 13,434 in the paleontological collection of the Peabody Museum of Yale University.

A single cranidium and two pygidia found in the St. Albans formation appear also to be referable to another new genus and species belonging in the subfamily Ogygiocarinae. This species is described as *Glossicephalus longifrons*, and its genus is defined.

Genus *Glossicephalus*, new genus

Cranidium greatly elongated, and narrow in front of the eyes. Glabella long. Eyes small. Pygidium segmented and rather wider than long.

This genus is remarkable for its long and narrow cranidium and glabella. The shape of the front of the cranidium is not known. It may have been spatulate, like the cranidium of *Megalaspis*, but the glabella is longer than in that genus, and, if the pygidium assigned to *Glossicephalus* really belongs to it, the pygidia of the two genera are different, that of *Glossicephalus* being relatively shorter than that of *Megalaspis*. The pygidium of the Vermont genus more resembles the pygidia of *Niobe* and *Ptychopyge*, but the cranidium differs from the cranidia of those genera in having the glabella longer and narrower and the eyes smaller. *Megalaspis*, *Niobe*, and *Ptychopyge* also lived much later than *Glossicephalus*. The genus nearest to *Glossicephalus* is *Glossopleura* Poulsen, which differs from *Glossicephalus* only in having a less elongate glabella.

Glossicephalus longifrons, new species

(Plate 6, figures 26, 30)

CRANIDIUM: The characters given for the cranidium in the definition of the genus are those of this species. They are well shown in the illustration.

PYGIDIUM: The pygidium which is believed to belong to this species has five segments in the axis and five poorly developed ribs on each pleural lobe. The ribs fade out as they reach the wide, flat flange of the shield.

OBSERVATIONS: Only a single cranidium and two pygidia of this species are known. The pygidia cannot be proved to belong to this species, and may be referable to some species of *Anomocare*. It seems to differ from *Anomocare* pygidia, however, in having the axis longer and wider, and the flattened rear part of the shield narrower.

LOCATION OF TYPES: The holotype cranidium is no. 40,221 in the paleontological collection of Princeton University. The pygidia are nos. 40,222 and 42,004 in the same collection.

A single small trilobite cranidium has been found in the St. Albans formation, which appears to require for its reception a new genus. This genus is, therefore, named and defined, and the species is named and described. Because he knows of no closely related genus and is ignorant of the shape of the pygidium of this genus, the writer has not attempted to assign the genus to a family. Possibly it will prove to need a new family for its reception.

Genus *Exigua*, new genus

The characters, as far as they are known, are those of the genotype, which is described.

Exigua quadrata, new species

(Plate 6, figure 24)

Only the cranidium is known. It is subquadrate, except for the rear corners, which are extended somewhat laterally. The glabella is convex and somewhat widened at the front, so that it is slightly club shaped, although its front is so nearly straight that the whole glabella is almost rectangular. The fixed cheeks are crossed by a faint ocular fillet. The eyes are small. The shole shield is convex, and its surface is smooth. The fixed cheeks are broadly confluent in front of the glabella, and the portion of the shield anterior to the glabella slopes evenly downward to a brim that is so poorly developed as to be scarcely distinguishable except at the anterior corners, where, because of an indentation behind it, it stands out clearly.

OBSERVATIONS: This species and genus are notable for their small size and quadrate glabella.

LOCATION OF TYPE: The holotype is no. 41083b in the paleontological collection of Princeton University.

Pygidia belonging to two species of small trilobites, probably referable to the same genus, have been found in the St. Albans formation. No cranidia believed to be referable to them have been discovered, and their family is, therefore, not known. They appear to be referable to the genus *Glyphaspis*, which was erected by Christian Poulsen[86] in 1927 for a new species from northwestern Greenland, which he named *Glyphaspis perconcava*, and which he founded on several pygidia and a single cranidium. The cranidium which Poulsen believed to belong with the pygidia of this species cannot be proved to be properly assigned; and, in the absence of conclusive evidence that the cranidium and pygidia do actually belong to a single species, one cannot determine with any degree of certainty in what family the genus belongs. The pygidia are, therefore, described as those of new species of *Glyphaspis*, but no attempt is made here to refer that genus to any family.

Glyphaspis pusilla, new species

(Plate 6, figure 22)

Only the pygidium is known, and only a few examples of it have been found.

The characters of these pygidia are well shown in the figures. The shields are small and wide, evenly rounded at the rear, with the axis well elevated above the rest of the surface, the ribs running clear to the edge of the shields, and the outer third of the shield strongly concave.

OBSERVATIONS: The pygidium of this species resembles that of *Glyphaspis perconcava*, but differs in having one less rib on each side and correspondingly fewer segments in the axis.

[86] C. Poulsen: *The Cambrian, Ozarkian and Canadian faunas of Northwest Greenland*, Meddelelser om Grønland, vol. 70 (1927) p. 273.

LOCATION OF TYPES: The holotype is no. 40196 in the paleontological collection of Princeton University. Paratypes are nos. 40175 (2 examples), 40215, 40216, and 40232 in the same collection.

Glyphaspis acuta, new species

(Plate 6, figure 17)

Only the pygidium is known, and only a single example of it has been discovered. Its characters are well shown in the illustration. The axis is notable for its narrowness, length, and acutely pointed rear end.

OBSERVATIONS: The pygidium of this species differs from that of *Glyphaspis pusilla* in having more segments and a longer and more pointed axis. It differs from *Glyphaspis perconcava* in the same respects.

LOCATION OF TYPE: The single known specimen, the holotype, is no. 41083a in the paleontological museum of Princeton University.

Three pygidia have been found in the St. Albans formation, which are, as far as the writer has been able to determine, different from any pygidia that have been found in *Centropleura* faunas elsewhere. They do not appear to be referable to any of the species represented by cranidia that have been found in the formation. As they do not seem to resemble any known pygidia of the same general age, and as the cephala of the species to which they belong are not known, all efforts to determine their families have proved fruitless. They are, therefore, figured and described as new species of new genera whose families are at present unknown.

Genus *Palella*, new genus

Only the pygidium is known. It is spade shaped, with the axis only about half as long as the whole shield and with several partially developed ribs on the pleural lobes. The whole shield is nearly flat, except for the axis, which is moderately convex. It is not known whether the axis is segmented.

The genotype and only known species is *Palella paradoxa*.

Palella paradoxa, new species

(Plate 6, figure 16)

Only the pygidium is known.

The characters mentioned in the definition of the genus and shown in the illustration of the single pygidium on which the species is based give all the information known concerning the species.

OBSERVATIONS: It is possible that this pygidium belongs with one of the kinds of cephala found in the St. Albans formation, but this does not seem probable from the evidence at hand.

LOCATION OF TYPE: The holotype is no. 40,140 in the paleontological collection of Princeton University.

Aliger, new genus

The characters of this genus, as far as they are known, are those of the type species, *Aliger venustus*. The genus is founded on a single pygidium, of which only the pleural portion of one side is preserved.

Aliger venustus, new species

(Plate 6, figure 25)

The pygidium on which this species is based is, as far as can be determined from the part of it which is preserved, broadly oval in shape, with an evenly rounded

rear edge. Its pleural lobes were crossed by strongly developed ribs, which reached clear to the edge of the shield. Each rib is divided into two parts by a deep pleural groove. The axis of the shield was probably relatively long and narrow, and crossed by transverse furrows; but so little of it is preserved that nothing certain can be learned of its form.

OBSERVATIONS: This pygidium is large enough to have belonged to some species of *Anomocare;* but it does not have the form characteristic of the pygidia of that genus, or any other genus known to the writer to occur in any late Paradoxidian fauna.

LOCATION OF TYPE: The holotype is no. 41069 in the paleontological collection of Princeton University.

Costapyge, new genus

The characters of this genus are those of the genotype, *Costapyge vermontensis,* which is described.

Costapyge vermontensis, new species

(Plate 6, figure 29)

The species is founded upon a single pygidium. The characters of this specimen are shown in the figure.

OBSERVATIONS: This pygidium resembles the pygidium assigned to *Ptychoparia? convexa,* but differs in having a shorter axis and in other minor details. It is possible that it belongs to one of the species of *Solenopleura* in the St. Albans fauna, or to one of the other species of that fauna, but this question cannot be answered without further evidence.

LOCATION OF TYPE: The holotype is no. 41086 in the paleontological collection of Princeton University.

Unassigned to Species

In addition to the parts of trilobites which have been assigned to definite species, there have been found in the St. Albans formation two kinds of free cheeks and two kinds of hypostomes, which it has not seemed feasible to refer to any particular species. They may belong to one of the species described in this paper, or they may be parts of other species, as yet unnamed. It is believed that further information will have to be secured before their relationships can be determined.

These four specimens are figured on plate 6, as figures 11, 14, 15, and 28. The free cheek illustrated in figure 11 is remarkable for its thick, curved spine, which is the only portion preserved. It is no. 41107a in the paleontological collection of Princeton University, and its counterpart is no. 41107b 2. The free cheek shown in figure 15 is also fragmentary. It has a sharply pointed spine and appears to have been of a peculiar shape, with a nearly straight outer edge and an unusual suture line. It is no. 41107b 1. The larger of the two hypostomes (fig. 14) has its anterior portion well and widely extended laterally, and has its rear corners extended outward and bent back in such a way that, as they are evenly rounded, they have the appearance of fixed cheeks on a trilobite cranidium. It is no. 41108 in the Princeton collection. The smaller of the two hypostomes (fig. 28) has its anterior portion extended only as small projections with rounded corners, and its posterior portion bordered by a wide, flat, brim, which attains its greatest width in the middle. It is no. 41109 in the Princeton collection.

Phylum CHORDATA
Class PISCES
Subclass OSTRACODERMI
Order HETEROSTRACI
Family not yet determined

Genus *Eoichthys* Bryant

This genus was erected by W. L. Bryant in 1926, to contain what seemed to him to be a new species of ostracoderm, a single plate of which was found by Charles Schuchert and the writer in the St. Albans formation. The new species that thus became the genotype of the genus, Bryant named *Eoichthys howelli*. Bryant's description of the genus, and his discussion of it, as published in the Report of the Vermont State Geologist for 1925-1926, are reproduced, in the description of the species, as his remarks applied to the species, as well as to the genus.

Eoichthys howelli Bryant

(Plate 2, figures 7, 8)

Eoichthys howelli, n. s., BRYANT, Geol. Soc. Am., Bull., vol. 37 (1926) p. 236. *Eoichthys howelli* BRYANT, Rept. Vermont State Geologist for 1925-1926 (1927) p. 125-126, pl. XII. *Eoichthys howelli* Bryant, HOWELL, Geol. Soc. Am., Bull., vol. 42 (1931) p. 347.

The original description of this species was based on the single holotype plate, the form of which was preserved only as an impression in shale. Bryant described this plate and named it in a paper read before the Paleontological Society in 1925. The following abstract of this paper was published in the Proceedings of the Society:

"Prior to the discovery of Ostracoderms in the Ordovician, it was thought that fishes arose in early Silurian times from ancestors to such generalized types as *Lasanius* and *Theolodus*, and that their predecessors of lower grade were soft-bodies and unlikely to be preserved as fossils. The structure of the Ordovician plates, however, shows such specialization as to render it probable that they had already undergone a long evolution of the exoskeleton, and that we may expect to find remains of fishlike animals in much older rocks. Possible evidence of a Cambrian Ostracoderm is found in the impression of a sculptured plate from Vermont found by Professors Schuchert and Howell, which is described under the name of *Eoichthys howelli*."[37]

Bryant's full description and discussion of the plates was published in 1927. The figure, plate XII, which accompanied it, is reproduced with the other figures of similar fossils found in the St. Albans formation that are figured in the present paper.

"Ever since the discovery in 1893 of Ordovician Ostracoderms in western North America, I have more or less confidently expected that ancestral forms with calcified dermal skeletons would ultimately be brought to light from the older rocks.

"Although mostly fragmentary, the Ordovician remains exhibit scales or plates of highly specialized structure, including dentine tubercles fused with underlying bony tissue, while these in turn sometimes coalesce into more or less extensive armor plates.

[37] W. L. Bryant: *Evidence of the presence of chordates in the Cambrian*, Geol. Soc. Am., Bull., vol. 37 (1926) p. 236.

"Previous to the discovery of these Ordovician fossils it seemed almost hopeless to search for remains of fishes much older than the Silurian Ostracoderms, for the reason that the primitive structure of such generalized forms as *Lasanius* and *Thelodus* suggested that the ancestral Ostracoderms were only beginning to evolve a hard dermal skeleton represented by tubercles of dentine in early Silurian times. *Lasanius* in particular occurs as hardly more than a mere stain in the rock with a few rows of the pointed scales on certain parts of the head and trunk.

"But when we find robust and complicated dermal plates in the Ordovician, showing a bony structure comparable with that of the advanced order of the diplorine Osteostracans, it seems certain that the Silurian Anaspidae were only survivors of much older forms, inheriting their primitive structure so far as the exoskeleton is concerned, and that we may look even below the Ordovician for evidence of their origin. For there must have been a long period of development from the primordial shagreen denticle to specialized plates like these if our conception of the history of such structures is correct.

"A possible realization of this hope lies in a small fossil recently discovered by Professors Howell and Schuchert in the Cambrian shales of Franklin County, Vermont, and now preserved in the geological museum of Princeton University. The fossil exhibits only an impression of the external surface of a scale or plate, but apparently shows its complete outline. The discovery of a Cambrian fossil whose sculptured surface is extremely suggestive of an ichthyc origin, seems to me of sufficient importance to justify a description and name, if only to attract attention to the find and to the probability that fish remains may be expected to occur in Cambrian rocks, even though one may only hazard a guess as to the true character and ordinal rank of the fossil in question.

"*Eoichthys howelli*, n. gen. n. sp., Plate XII.

"*Type.*—Impression in shale of a small plate 3 mm. in length by slightly more than 2 mm. in width.

"*Formation and locality.*—St. Albans shale, near St. Albans, Franklin County, Vermont.

"An elipsoid plate truncated at one end. Ornament consisting of smooth, conical tubercles whose bases are more or less confluent into rows radiating fan-wise from a focal point near the truncate border, where there are one or more detached (non-confluent) tubercles. Below this focal point a stronger pair of these tuberculate costae diverge towards the outer margins of the truncated border. A deep sulcus crossing the plate separates this pair of costae from the others. On the same slab with the type there are to be seen other plates in section, one of which is four or five millimeters in length and seems to exhibit the cancellous tissue characteristic of the Ostracoderms, but this appearance may be due to weathering as the plates are badly decomposed.

"If this plate is as seems probable of vertebrate origin it is quite certainly one of those polygonal tesserae which defended the head and fore trunk of some hitherto unknown diplorine Ostracoderm, and we have here the surprising evidence that at even this early period certain Chordates had undergone a complicated and presumably long extended evolution of the exoskeleton, resulting in a fusion of dentine tubercles and the development of an underlying calcified tissue with which these have coalesced."[38]

In a letter to the writer, written in 1932, Bryant added to what he had said in 1927 the following information.

"I believe the little problematical fossil, *Eoichthys howelli*, actually is of vertebrate origin and belongs to some primitive member of the class Ostracodermi.

"I also believe that the Ostracodermi are related to the recent Cyclostomes rather than to true fishes. All of the known Ostracodermi, while in many respects primitive, in other features are highly specialized, and some were even degenerate in Lower Devonian times. They therefore had descended from more primitive and generalized ancestors.

"I further suppose that small placoid scales originated in these primitive Ostracoderms and gradually developed around mouths, sense organs and fins, in many cases fusing together into larger plates.

[38] W. L. Bryant: *Evidence of the presence of chordates in the Cambrian*, 15th Biennial Rept. Vermont State Geologist, for 1925-1926 (1927) p. 125-126, pl. XII.

"It would be unwise to try to fit a single scale, known only by its impression in the matrix, and whose microscopic structure cannot be studied, into a more exact classification based on much later Silurian and Devonian forms.

"Inasmuch as scales of a species of *Thelodus* have been found by H. C. Stetson in the Ordovician bone bed of Canyon City, Colorado, one might be tempted to guess that our little plate likewise belongs to the Heterostraci, but it would only be a guess."

The writer has now found one more plate of this sort, which is presumed to be referable to this species. It is figured here, and is no. 40244 in the paleontological collection of Princeton University. The holotype is no. 8205 in the same collection.

CORRELATION

In the somewhat more than one hundred years during which the Cambrian rocks of Vermont have been studied by geologists the beds now known to contain the *Centropleura vermontensis* fauna have been variously correlated. They were at first referred, together with the other Cambrian rocks of the region, to the "Transition" division of Werner's classification. Later, when the "Transition" rocks of Vermont were studied more in detail and were subdivided, the St. Albans beds appear to have been assigned to the "red sandrock series", which was considered to be the uppermost division of the "Champlain group" of the "Palaeozoic", "Lower Silurian", or "Secondary" rocks. This "red sandrock series" was supposed to be younger than any of the other rocks in the region except those of the Quaternary. In 1842 and succeeding years, Ebenezer Emmons appears to have included the *Centropleura* beds in his "Taconic System", and, in 1855, he referred them to the "upper division of the Taconic rocks", which he believed to be older than the "Lower Silurian". In the latter year, Sir William Logan mapped them as a part of the "Hudson River group"; and, in 1858, Edward Hitchcock apparently also referred them to this "group".

In a paper, published in 1923, in which he presented the first even approximately correct detailed stratigraphic section of the Cambrian beds of northwestern Vermont, Arthur Keith [39] tentatively placed the horizon of the *Centropleura* beds as in the upper part of his Colchester Shale (now known as the Parker Shale, in the lower part of which occurs the long famous *Olenellus* fauna of that region), or else in the dolomite overlying the "Colchester", which he then called the Milton Dolomite, but which has since been found to be different in age from the true Milton, and, hence, has been given a new name, Rugg Brook. The exact age of this last formation is still unknown; it overlies the Parker Shale and underlies the St. Albans Shale, but no fossils have been found in it.

In 1922 the writer began a search for Paradoxidian fossils in northwestern Vermont in the hope that he might learn more of the exact

[39] Arthur Keith: *Cambrian succession of northwestern Vermont*, Am. Jour. Sci., 5th ser., vol. 5 (1923) p. 97-139.

nature of their fauna and its precise position in the stratigraphic succession there. He succeeded in finding the fauna in an outcrop that proved to be part of a block of St. Albans Shale, which had been moved by a Pleistocene glacier, and in pebbles in a nearby outcrop of limestone conglomerate (Mill River formation), but did not discover that the beds from which the shale block had come underlay the conglomerate. Following the lead opened by this discovery, Keith and Schuchert made a further search and found the fauna in place beneath the conglomerate. The position of the fauna in the local stratigraphic column was thus at last determined. It remained only to collect enough specimens to permit the determination of the faunas's exact age and relationships.

A comparison of this fauna with its nearest relative discloses the fact that it is of late Paradoxidian age—perhaps the youngest *Paradoxides* fauna yet discovered, and a *Paradoxides* fauna in which *Paradoxides* itself is so rare and the related genus, *Centropleura*, is so much more common that it seems more appropriate to call it, rather, a *Centropleura* fauna. The most nearly related known fauna is the one described in 1930 by Holm and Westergaard from Bennett Island, in the Arctic Ocean, north of Siberia, which is probably just a little older than the St. Albans fauna and serves to connect it with the *Paradoxides forchhammeri* fauna of Scandinavia. Similar faunas appear to be present in northeastern Asia, but so little is known of them as yet that no satisfactory comparisons can be made with them.

The St. Albans fauna of Vermont is of particular interest both because it is apparently the youngest Paradoxidian fauna known and because it shows relationships to faunas found elsewhere in the world, further evidence on whose ages relative to the Paradoxidian faunas have long been needed. It adds one more link in the long chain of Cambrian life history which the students of that ancient period are slowly forging. The presence of a chordate—perhaps the oldest chordate known—gives an added interest to the fauna.

PRINCETON UNIVERSITY, PRINCETON, N. J.
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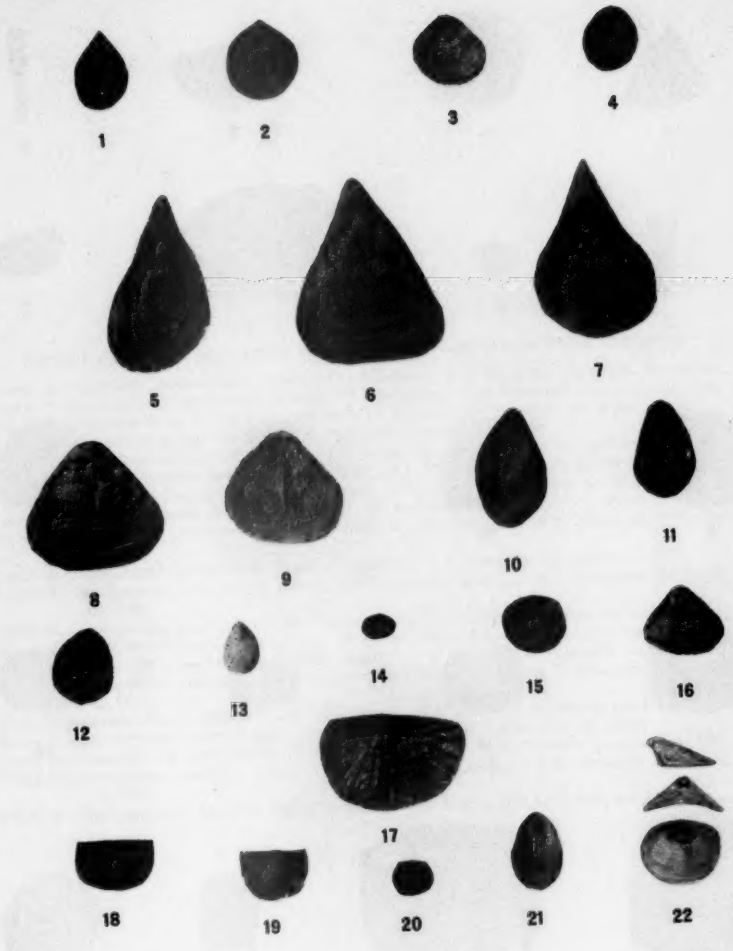
READ BEFORE THE PALEONTOLOGICAL SOCIETY, DECEMBER 29, 1930.

EXPLANATION OF PLATES

PLATE 1

MIDDLE CAMBRIAN BRACHIOPODA FROM VERMONT

Figure 1.—*Obolus clarae* Howell. Ventral valve, the holotype. × 2, Princeton University no. 9672.
Figure 2.—*Obolus clarae* Howell. Dorsal valve. × 2, Princeton University no. 9601.
Figure 3.—*Obolus clarae* Howell. Dorsal valve. × 2, Princeton University no. 9598.
Figure 4.—*Obolus clarae* Howell. Dorsal valve. × 2, Princeton University no. 9593.
Figure 5.—*Lingulella (Lingulepis) vermontensis* Howell. Ventral valve. × 2, Princeton University no. 9849.
Figure 6.—*Lingulella (Lingulepis) vermontensis* Howell. Ventral valve. × 2, Princeton University no. 9571.
Figure 7.—*Lingulella (Lingulepis) vermontensis* Howell. Ventral valve, the holotype. × 2, Princeton University no. 9570.
Figure 8.—*Lingulella (Lingulepis) vermontensis* Howell. Dorsal valve. × 2, Princeton University no. 9603.
Figure 9.—*Lingulella (Lingulepis) vermontensis* Howell. Dorsal valve. × 2, Princeton University no. 9602.
Figure 10.—*Lingulella longa* Howell. Dorsal valve. × 2, Princeton University no. 9655.
Figure 11.—*Lingulella longa* Howell. Dorsal valve, the holotype. × 2, Princeton University no. 9648.
Figure 12.—*Lingulella parvula* Howell. × 6, Princeton University no. 9806.
Figure 13.—*Lingulella parvula* Howell. Dorsal valve, the holotype. × 5, Princeton University no. 40134.
Figure 14.—*Acrothele franklinensis* Howell. Ventral valve, the holotype. × 1, Princeton University no. 9656.
Figure 15.—*Acrothele franklinensis* Howell. Dorsal valve. × 2, Princeton University no. 9657.
Figure 16.—*Acrotreta rara* Howell. Dorsal? valve, the holotype. × 6, Princeton University no. 9785.
Figure 17.—*Protorthis vermontensis* Howell. × 4, Princeton University no. 5710.
Figure 18.—*Protorthis vermontensis* Howell. Dorsal valve, the holotype (counterpart). × 2, Princeton University no. 9676b.
Figure 19.—*Protorthis vermontensis* Howell. Dorsal valve, the holotype. × 2, Princeton University no. 9676a.
Figure 20.—*Protorthis vermontensis* Howell. Dorsal? valve. × 1.
Figure 21.—*Protorthis vermontensis* Howell? Valve distorted by pressure? × 2, Princeton University no. 9677.
Figure 22a-c.—*Acrotreta dubia* Howell. Ventral valve, the holotype. × 10, Princeton University no. 9675.



MIDDLE CAMBRIAN BRACHIOPODA FROM VERMONT

MIDDLE CAMBRIAN MOLLUSCA, TRILOBITA, AND CHORDATA FROM VERMONT

PLATE 2

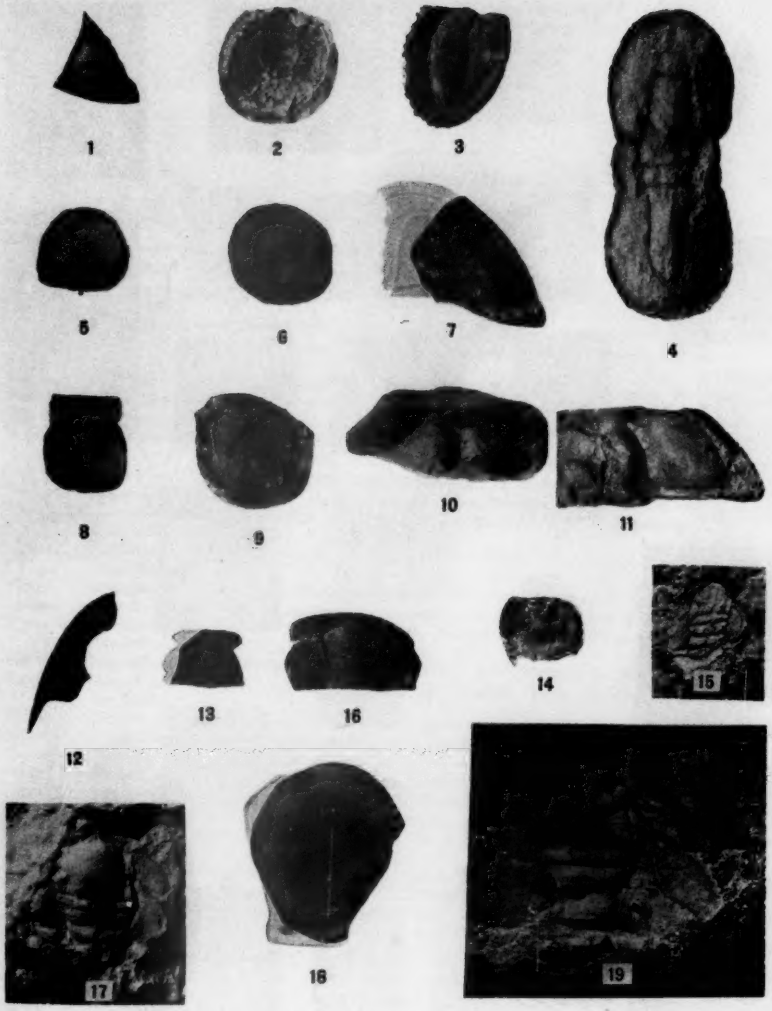
MIDDLE CAMBRIAN MOLLUSCA, TRILOBITA, AND CHORDATA FROM VERMONT

Figure 1.—*Helcionella vermontensis* Howell. The holotype. × 2, Princeton University no. 40200a.
Figure 2.—*Straparollina vermontensis* Howell. The holotype. × 6, Princeton University no. 9033.
Figure 3.—*Hyolithes rarus* Howell. The holotype. × 6, Princeton University no. 40240.
Figure 4.—*Orthotheca acicula* Howell. × 2, Princeton University no. 40239.
Figure 5.—*Orthotheca vermontensis* Howell. The holotype. × 2, Princeton University no. 40241.
Figure 6.—*Orthotheca dubia* Howell. The holotype. × 2, Princeton University no. 40642.
Figure 7.—*Eoichthys howelli* Bryant. The holotype. × 10, Princeton University no. 8205.
Figure 8.—*Eoichthys howelli* Bryant. Plesiotype. × 4, Princeton University no. 40244.
Figure 9.—*Spinagnostus franklinensis* Howell. Cephalon, the holotype. × 5, Princeton University no. 9679a.
Figure 10.—*Spinagnostus franklinensis* Howell. Cephalon. × 5, Princeton University no. 9682.
Figure 11.—*Spinagnostus vermontensis* Howell. Thorax and pygidium. × 6, Princeton University no. 9680.
Figure 12.—*Armagnostus megalaxis* Howell. Cephalon. × 5, Princeton University no. 41124.
Figure 13.—*Spinagnostus franklinensis* Howell. Pygidium. × 5, Princeton University no. 9683.
Figure 14.—*Spinagnostus franklinensis* Howell. Pygidium. × 5, Princeton University no. 9686.
Figure 15.—*Armagnostus megalaxis* Howell. Pygidium, the holotype. × 2, Princeton University no. 9786.
Figure 16.—*Armagnostus megalaxis* Howell. Pygidium. × 5, Princeton University no. 9790.
Figure 17.—*Quadragnostus solus* Howell. Cephalon. × 6, Princeton University no. 40126.
Figure 18.—*Quadragnostus solus* Howell. Pygidium, the holotype. × 4, Princeton University no. 9793.
Figure 19.—*Clavagnostus aequalis* Howell. Pygidium, the holotype. × 6, Princeton University no. 5768.
Figure 20.—*Cyclopagnostus hesperius* Howell. Cephalon. × 6, Princeton University no. 9797.

PLATE 3

MIDDLE CAMBRIAN MOLLUSCA AND TRILOBITA FROM VERMONT

Figure 1.—*Helcionella americana* Howell. The holotype. × 2, Princeton University no. 40243.
Figure 2.—*Cyclopagnostus hesperius* Howell. Pygidium, the holotype. × 5, Princeton University no. 9796.
Figure 3.—*Hastagnostus angustus* Howell. Pygidium. × 5.
Figure 4.—*Hastagnostus angustus* Howell. Entire test, the holotype. × 4, Princeton University no. 9795.
Figure 5.—*Grandagnostus vermontensis* Howell. Cephalon, the holotype. × 2, Princeton University no. 9736.
Figure 6.—*Grandagnostus vermontensis* Howell. Cephalon. × 2, Princeton University no. 9754.
Figure 7.—*Conocoryphe artagena* Howell. The holotype. × 4, Princeton University no. 9925.
Figure 8.—*Grandagnostus vermontensis* Howell. Thorax and pygidium. × 5, Princeton University no. 9757.
Figure 9.—*Grandagnostus vermontensis* Howell. Pygidium. × 2, Princeton University no. 9837.
Figure 10.—*Elyx americanus* Howell. Cranidium, the holotype. × 1½, Princeton University no. 9880a.
Figure 11.—*Elyx americanus* Howell. Cranidium. × 2, Princeton University no. 9882.
Figure 12.—*Paradoxides franklini* Howell. Free cheek. × 2, Princeton University no. 9819a.
Figure 13.—*Paradoxides franklini* Howell. Cranidium, the holotype. × 2, Princeton University no. 9818.
Figure 14.—*Centropleura vermontensis* Howell. Pygidium. × 4, Princeton University no. 9830.
Figure 15.—*Centropleura vermontensis* Howell. Cranidium, the holotype. × 1, Princeton University no. 9809.
Figure 16.—*Centropleura vermontensis* Howell. Young cranidium. × 5, Princeton University no. 9939.
Figure 17.—*Centropleura vermontensis* Howell. Cranidium. × 2, Princeton University no. 9996.
Figure 18.—*Centropleura vermontensis* Howell. Hypostome. × 1, Princeton University no. 9835.
Figure 19.—*Centropleura vermontensis* Howell. Cranidium. × 1, Princeton University no. 9810.



MIDDLE CAMBRIAN MOLLUSCA AND TRILOBITA FROM VERMONT

MIDDLE CAMBRIAN MOLLUSCA AND TRILOBITA FROM VERMONT

PLATE 4

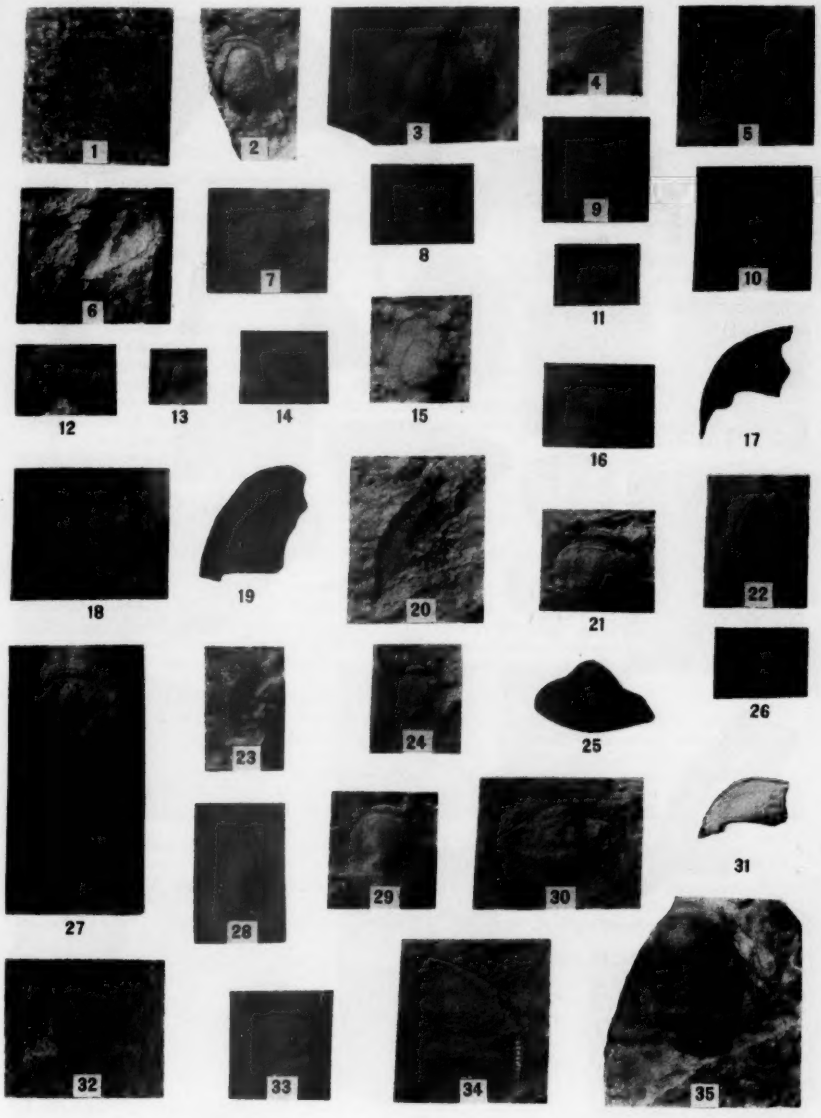
MIDDLE CAMBRIAN MOLLUSCA AND TRILOBITA FROM VERMONT

Figure 1.—*Paradoxides? pusulosus* Howell. Free cheek, the holotype. × 1, Princeton University no. 40200a.
Figure 2.—*Solenopleura vermontensis* Howell. Cranidium, the holotype. × 2, Princeton University no. 9886a.
Figure 3.—*Solenopleura vermontensis* Howell. Cranidium. × 2, Princeton University no. 9894.
Figure 4.—*Solenopleura franklinensis* Howell. Cranidium, the holotype. × 4, Princeton University no. 9908.
Figure 5.—*Solenopleura franklinensis* Howell. Cranidium. × 2, Princeton University no. 9901.
Figure 6.—*Solenopleura vermontensis* Howell. Pygidium. × 2, Princeton University no. 9942a.
Figure 7.—*Solenopleura vermontensis* Howell. Pygidium. × 2, Princeton University no. 9955.
Figure 8.—*Solenopleura franklinensis* Howell. Free cheek. × 6, Princeton University no. 9952.
Figure 9.—*Solenopleura franklinensis* Howell. Thorax. × 2, Princeton University no. 9966b.
Figure 10.—*Solenopleura franklinensis* Howell? Hypostome? × 5, Princeton University no. 9927.
Figure 11.—*Solenopleura franklinensis* Howell. Cranidium. × 2, Princeton University no. 9799a.
Figure 12.—*Solenopleura pusilla* Howell. Cranidium, the holotype. × 5, Princeton University no. 40228.
Figure 13.—*Solenopleura tuberculata* Howell. Cranidium, the holotype. × 2, Princeton University no. 9992.
Figure 14.—*Solenopleura franklinensis* Howell. Pygidium. × 2, Princeton University no. 9978.
Figure 15.—*Albansia obesa* Howell. Cranidium, the holotype. × 6, Princeton University no. 40146.
Figure 16.—*Solenopleura ? latimargo* Howell. Cranidium, the holotype. × 2, Princeton University no. 40000.
Figure 17.—*Solenopleura tuberculata* Howell. Young cephalon. × 2, Princeton University no. 9937a.
Figure 18.—*Solenopleura spissa* Howell. Cranidium, the holotype. × 2, Princeton University no. 9902a.
Figure 19.—*Albansia obesa*. Free cheek. × 6, Princeton University no. 40142.
Figure 20.—*Albansia pusilla* Howell. Cranidium. × 5, Princeton University no. 40123.
Figure 21.—*Solenopleura spissa* Howell. Pygidium. × 4, Princeton University no. 40233b.
Figure 22.—*Albansia obesa* Howell. Cranidium. × 6, Princeton University no. 40192.
Figure 23.—*Albansia pusilla* Howell. Pygidium. × 8, Princeton University no. 41102a.
Figure 24.—*Albansia pusilla* Howell. Cranidium, the holotype. × 5, Princeton University no. 40117.
Figure 25.—*Solenopleurella rara* Howell. Cranidium, the holotype. × 5, Princeton University no. 41110.
Figure 26.—*Albansia conveza* Howell. Cranidium, the holotype. × 6, Princeton University no. 40200b.
Figure 27.—*Albansia conveza* Howell. Free cheek. × 5, Princeton University no. 40213.
Figure 28. —*Albansia conveza* Howell. Cranidium. × 5, Princeton University no. 40228.
Figure 29.—*Orthotheca acicula* Howell. The holotype. × 4, Princeton University no. 9937.

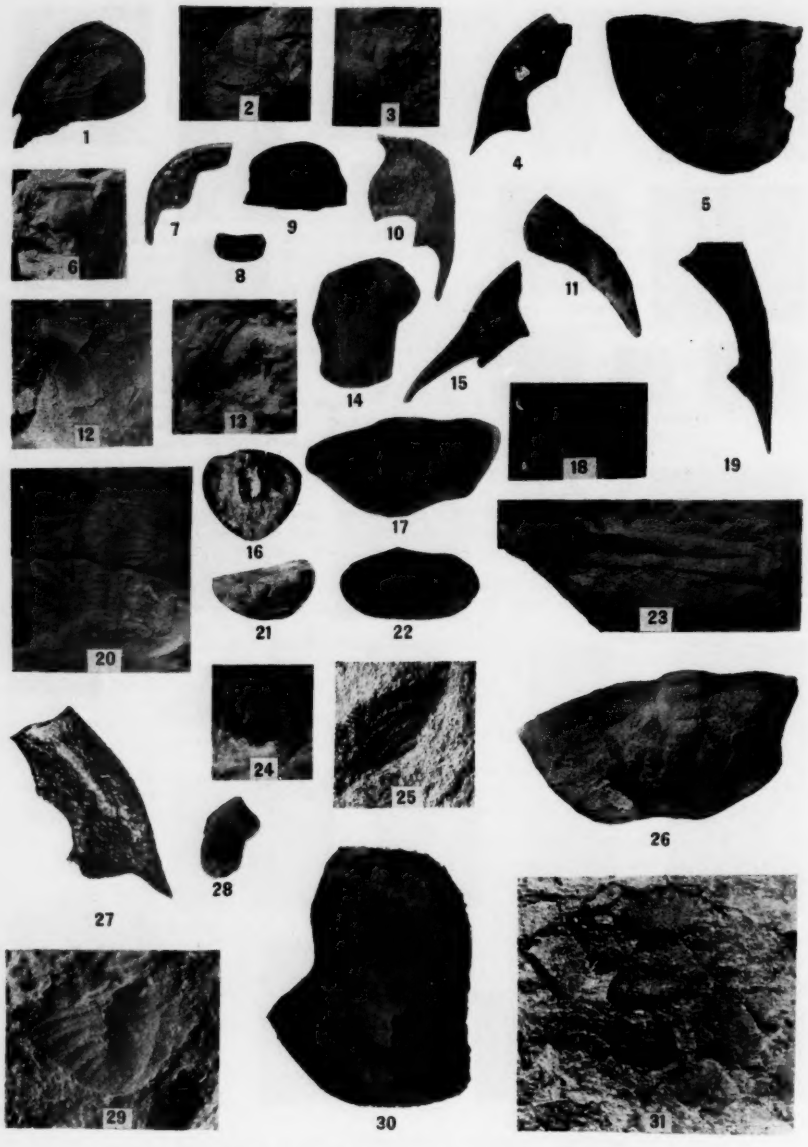
PLATE 5

MIDDLE CAMBRIAN TRILOBITA FROM VERMONT

Figure 1.—*Albansia magna* Howell. Cranidium, the holotype. × 6, Princeton University no. 40115a.
Figure 2.—*Albansia magna* Howell. Cranidium. × 5, Princeton University no. 40195.
Figure 3.—*Ptychoparia ? conveza* Howell. Cranidium, the holotype. × 2, Princeton University no. 40003.
Figure 4.—*Ptychoparia ? conveza* Howell. Free cheek. × 2, Princeton University no. 40015.
Figure 5.—*Ptychoparia ? conveza* Howell. Young cranidium. × 5, Princeton University no. 40014.
Figure 6.—*Ptychoparia? conveza* Howell. Pygidium. × 2, Princeton University no. 40021.
Figure 7.—*Champlainia rectimargo* Howell. Cranidium. × 2.
Figure 8.—*Champlainia rectimargo* Howell. Cranidium, the holotype. × 2, Princeton University no. 40093.
Figure 9.—*Champlainia rectimargo* Howell. Cranidium. × 2, Princeton University no. 40099.
Figure 10.—*Elrathia longa* Howell. Cranidium, the holotype. × 2, Princeton University no. 40055.
Figure 11.—*Elrathia longa* Howell. Pygidium. × 2, Princeton University no. 40058.
Figure 12.—*Ptychoparia? conveza* Howell. Pygidium. × 2, Princeton University no. 40017.
Figure 13.—*Brunswickia quadrata* Howell. Cranidium, the holotype. × 2, Princeton University no. 40092a.
Figure 14.—*Agraulos perkinsi* Howell. Cranidium, the holotype. × 2, Princeton University no. 9997.
Figure 15.—*Agraulos convexus* Howell. Cranidium, the holotype. × 3, Princeton University no. 40126.
Figure 16.—*Micragraulos franklini* Howell. Cranidium, the holotype. × 2, Princeton University no. 40135.
Figure 17.—*Elrathia longa* Howell. Free cheek. × 4, Princeton University no. 40077.
Figure 18.—*Ptychoparia ? hispida* Howell. Cranidium, the holotype. × 2, Princeton University no. 40054.
Figure 19.—*Ptychoparia ? hispida* Howell. Free cheek. × 2, Princeton University no. 5718.
Figure 20.—*Micragraulos franklini* Howell. Free cheek. × 6, Princeton University no. 40143.
Figure 21.—*Micragraulos franklini* Howell. Cranidium. × 6, Princeton University no. 40142.
Figure 22.—*Elrathia longa* Howell ? Hypostome. × 5, Princeton University no. 40070.
Figure 23.—*Micragraulos decorus* Howell. Free cheek. × 6, Princeton University no. 40161.
Figure 24.—*Micragraulos decorus* Howell. Cranidium, the holotype. × 1½, Princeton University no. 40153.
Figure 25.—*Micragraulos franklini* Howell. Pygidium. × 4, Princeton University no. 40146.
Figure 26.—*Elrathia longa* Howell. Pygidium. × 2, Princeton University no. 40076.
Figure 27.—*Vermontella clarae* Howell. Cranidium (the holotype) and free cheek. × 2, Princeton University no. 40105.
Figure 28.—*Micragraulos decorus* Howell. Cranidium. × 2, Princeton University no. 40170.
Figure 29.—*Micragraulos decorus* Howell. Young cranidium. × 4, Princeton University no. 41106a.
Figure 30.—*Micragraulos decorus* Howell. Pygidium. × 3, Princeton University no. 40165.
Figure 31.—*Champlainia rectimargo* Howell. Free cheek. × 5, Princeton University no. 41067.
Figure 32.—*Brunswickia quadrata* Howell. Cranidium. × 6, Princeton University no. 5769.
Figure 33.—*Vermontella clarae* Howell. Cranidium. × 2, Princeton University no. 40109.
Figure 34.—*Champlainia rectimargo* Howell. Free cheek. × 6, Princeton University no. 40094.
Figure 35.—*Centropleura vermontensis* Howell. Cranidium. × 1½, Princeton University no. 9997.



MIDDLE CAMBRIAN TRILOBITA FROM VERMONT



MIDDLE CAMBRIAN CRINOIDEA AND TRILOBITA FROM VERMONT

PLATE 6

MIDDLE CAMBRIAN CRINOIDEA AND TRILOBITA FROM VERMONT

Figure 1.—*Agrauloides vermontensis* Howell. Cephalon and thorax, the holotype. × 1½, Princeton University no. 40171.

Figure 2.—*Dolichometopus vermontensis* Howell. Cranidium, the holotype. × 2, Princeton University no. 40223.

Figure 3.—*Conagraulos rarus* Howell. Cranidium, the holotype. × 2, Princeton University no. 40174.

Figure 4.—*Anomocare vermontense* Howell. Free cheek. × 2, Princeton University no. 40212a.

Figure 5.—*Anomocare vermontense* Howell. Pygidium, the holotype. × 1, Princeton University no. 40206.

Figure 6.—*Conoides edsoni* Howell. Cranidium. × 2, Princeton University no. 9998.

Figure 7.—*Dolichometopus vermontensis* Howell. Free cheek. × 5, Princeton University no. 40168.

Figure 8.—*Champlainia rectimargo* Howell. Pygidium. × 2, Princeton University no. 40095.

Figure 9.—*Agrauloides vermontensis* Howell. Cranidium. × 1, Princeton University no. 40173.

Figure 10.—*Conagraulos rarus* Howell. Free cheek. × 4, Princeton University no. 40129.

Figure 11.—Genal spine of trilobite, genus and species undetermined. × 3, Princeton University no. 41107a.

Figure 12.—*Anomocarella ? conveza* Howell. Free cheek, the holotype. × 2, Princeton University no. 41125a.

Figure 13.—*Conoides edsoni* Howell. Free cheek. × 6, Princeton University no. 40104.

Figure 14.—Hypostome of trilobite, genus and species undetermined. × 3, Princeton University no. 41108.

Figure 15.—Genal spine of trilobite, genus and species undetermined. × 3, Princeton University no. 41107b.

Figure 16.—*Palella paradoza* Howell. Pygidium, the holotype. × 3, Princeton University no. 40140.

Figure 17.—*Glyphaspis acuta* Howell. Pygidium, the holotype. × 4, Princeton University no. 41083a.

Figure 18.—*Conagraulos rarus* Howell. Pygidium. × 5, Princeton University no. 40159a.

Figure 19.—*Anomocare vermontense* Howell. Free cheek. × 1½, Princeton University no. 40208.

Figure 20.—*Conoides edsoni* Howell. Cranidium and thorax, the holotype. × 1, Princeton University no. 9990a.

Figure 21.—*Conoides edsoni* Howell. Pygidium. × 2, Princeton University no. 40185.

Figure 22.—*Glyphaspis pusilla Howell.* Pygidium, the holotype. × 4, Princeton University no. 40196.

Figure 23.—*Anamocare? rex* Howell. Pleuron, the holotype. × 1, Princeton University no. 40209a.

Figure 24.—*Exigua quadrata* Howell. Cranidium, the holotype. × 3½, Princeton University 41083b.

Figure 25.—*Aliger venustus* Howell. Pygidium, the holotype. × 1½, Princeton University no. 41069.

Figure 26.—*Glossicephalus longifrons* Howell. Pygidium. × 1½, Princeton University no. 40222a.

Figure 27.—*Anomocare dubium* Howell. Free cheek, the holotype. × 3, Princeton University no. 40074.

Figure 28.—Hypostome of trilobite, genus and species undetermined. × 6, Princeton University no. 41109.

Figure 29.—*Costapyge vermontensis* Howell. Pygidium, the holotype. × 3, Princeton University no. 41086a.

Figure 30.—*Glossicephalus longifrons* Howell. Cranidium, the holotype. × 1½, Princeton University no. 40221.

Figure 31.—Plates of Eocrinoidea, genus and species undetermined. × 3, Princeton University no. 41250.